1987

Capacity Planning in a Discrete Item Manufacturing Environment

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CAPACITY PLANNING IN A DISCRETE ITEM MANUFACTURING ENVIRONMENT

BY

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B.S.E., Montana State University, 1981

RESEARCH REPORT

Submitted in partial fulfillment of the requirements
for the degree of Master of Science in Engineering
in the Graduate Studies Program
of the College of Engineering
University of Central Florida
Orlando, Florida

Spring Term
1987

ABSTRACT

Capacity planning is a medium-to-long term production planning tool that enables management to better understand how the demand of its customers have and will affect the available capacity planning. For a successful production and planning control system, management needs to consider the availability of not only the materials and component, but also the required manufacturing capacity.

Several capacity planning techniques that deal with capacity planning in a discrete item manufacturing (job shop environment) are discussed in this report. These are Resource Requirement Planning, Rough Cut Capacity Planning, Capacity Requirement Planning, Operation Sequence, Input Output, and Simulation.

A computerized capacity planning system for the IBM Microcomputer family is developed and presented in this report. The system maintains the profile of the job shop in a data base along with data pertinent to various products that can be manufactured in the shop. Projected orders for the planning period are input to the system with their associated quantities and delivery dates. The system has its own data base management component which is used in creating, updating, and reviewing the data base contents.

The capacity planning algorithm uses information retrieved from the data base, and the user's input (loading rule and planning horizon) to simulate the behavior of the shop work centers along the planning horizon. The process involves loading (accumulating) the various elements of each order in its pertinent work center using a specified loading rule (currently it uses forward and backward loading).

The system uses the loading policies in generating the scenarios, and the user is consulted in the selection of the policy to apply. Other scenarios may be tried by "splitting" the orders with various ratios to meet the delivery dates by the current capacity. The system will enable the user to select a course of action such as acquiring more resources, shift work loads, increase work shifts of specific work center for certain time periods, and/or subcontracting for some orders. Efficiency figures, based on a number of criteria, are produced along with the resource allocation for the planning period to guide the user in his/her selection of the proper scenario. Various reports that are generated by the system should aid the planner (Industrial Engineer) in making a complete analysis of the required future capacity and in identifying bottlenecks. The system is designed to encompass the best technique in operation and communicate with the user.

The system will facilitate the future research in the capacity planning problem such as the development and testing of

efficiency factors that can be used to compare various loading rules and the development of a heuristical procedure for leveling the required capacity of each work center along the planning horizon.

Future expansion of the system might include: addition of subroutine that will change the normal calendar dates to working days, calendar and vice versa, priority rules for processing the orders, and/or capacity leveling subroutine. The system also might be modified to produce a list of all jobs (orders) that are needed to be processed at each work center per planning period (time bucket) along the planning horizon.

ACKNOWLEDGEMENTS

I am grateful to the faculty and staff of the Department of Industrial Engineering and Management Systems at the University of Central Florida for their help and understanding.

I would also like to express my sincere thanks and deep appreciation to the following people:

- My advisor, Dr. Yasser A. Hosni, for his guidance, assistance, and support throughout all my study at UCF.
- My committee members, Dr. Gary E. Whitehouse, for his fatherly advice, assistance, and moral support; and Dr. Jose A. Sepulveda, for his support and understanding.
- Dr. William Swart, for his trust and encouragement.
- My brother, Saad, for his loving encouragement and support.
- And finally, to my wife and my two daughters--I would not have done this without them. Their love and companionship throughout was essential.

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INTRODUCTION

For the implementation of an effective production planning and control system in a manufacturing environment, it is necessary to consider the availability of not only components and materials but also the required manufacturing capacity (availability of machines as well as manpower).

Capacity planning is a medium-to-long-term production planning tool that enables management to better understand how the demands of its customers have and will affect the available capacity of the production facilities. The capacity planning does affect and is affected by the other elements of the production system such as the material requirement planning and master scheduling. Forecasting may be used to seed the production plan when the future is unknown. The production plan is translated into capacity requirement. The quantities of released and planned orders and their due dates are used to determine future capacity requirements over the planning horizon.

The main objective of capacity planning is to optimize the use of available resources and satisfy the production schedule and order requirements. Further, capacity planning should minimize the capital tied down in production, meet delivery dates, and provide management with information about the future required

capacity of each of the work centers that are necessary in order to met the master production schedule. If the capacity planning system shows that the available capacity is inadequate to meet the planned requirements, then management can take the remedial action required to increase the capacity by subcontracting, overtime working, or working two shifts in critical areas. It might also be possible to reduce bottlenecks in some areas by shifting resources from one area to another. If this is not possible, changes can be made to the master schedule.

The objective of this research is to review and evaluate a number of techniques and methods which deal with capacity planning in a discrete item manufacturing (job shop) environment; and to introduce a microcomputer based system for solving limited size capacity planning problems using some of the reviewed capacity planning techniques.

The report consists of two main parts:

1. A technique overview section -- This is an overview of the existing capacity planning techniques. Each technique is put into perspective by relating it to an overall manufacturing planning and control system. A case example may be used to explain the use of the technique.

2. A computerized system for capacity planning -- The description and documentation of a microcomputer based capacity planning system was developed for the IBM microcomputer family. The developed system employs the Capacity Requirement Technique

(infinite loading) with options for backward scheduling, forward scheduling and order splitting.

The system, as described later, receives information pertinent to product(s), order(s), and production facilities from a job shop data base. It then may generate a number of scenarios which look into the possibility of satisfying the delivery dates subject to the work center capacities and the product(s) operational sequence. Several reports are produced by the system to aid the planner in obtaining the required capacity. The system is also equipped with a graphical component that will display on the monitor the load profile for each work upon the user demand.

Part one of this report consists of chapters I through IV. Chapter I gives the background and concepts of capacity planning and the various forms of capacity in the manufacturing environment. Chapter II introduces the basic computations used in capacity planning techniques, and chapters III and IV review techniques used in capacity planning with the advantages and disadvantages of each.

Part two, which includes chapters V through VIII, starts by introducing the developed microcomputer based system in a block diagram form, description of its components, hardware requirements, and the expected output in Chapter V, followed by the detailed logic of the system components in Chapter VI. Chapter VII details a typical application for the system demonstrating its capability.

The report ends by a conclusion chapter (Chapter VIII) in which other points of research and possible expansion of the system is introduced.

A listing of the system source code is found the Appendix.

CHAPTER I

BACKGROUND AND BASIC CONCEPTS OF CAPACITY PLANNING

One of the main functions of capacity planning is to forecast the work load at each work center for each time period-time bucket. Thus, management can adjust resources to avoid bottlenecks and estimate reliable delivery dates for incoming orders.

Traditionally, capacity planning was done manually using the Gant-chart technique. However, as the market place grew more competitive, computers became relatively cheap and were introduced into the production environments. It then became clear that more formalized and systematic techniques were required. Two capacity planning approaches (infinite and finite capacity planning) were developed (Graziono 1974). Although these two techniques were designed to be programmed for computers, they were still based on the Gant-chart technique.

Capacity loading techniques are much too time-consuming when done manually. The outcome would be considered "unsmoothed" or "unleveled" capacity load in the shop production facilities. An "unsmoothed" capacity projection depicts what the load on the shop would be if there were sufficient manpower and machines to produce all input orders. This is rarely the situation, and invariably

capacity loads will have to be moved or "smoothed" into under loaded planning periods occurring earlier in time. The major contribution of using computers is the speed and ease of generating a variety of scenarios for many "loading" policies. Thus, the planner should be informed of opportunities which may produce a smoothed, leveled load for the production work centers while meeting the delivery dates for the orders.

Before introducing the various types of capacity planning, some basic concepts need to be introduced in order to help understand these techniques.

Definition of Capacity

Capacity is the rate that can be measured at either the input side or the output side of a productive system (Wemmerlov 1984). For a manufacturing firm, the productive resource usually consists of material, labor, and equipment. For a service-oriented company, the customers themselves can be considered "material" along with labor and equipment. A car wash in a service system (with available capacity measured at the output side) could be stated as 10 cars per hour. If the system is an airplane, its available capacity (measured at the input side) could be 125 seats per flight. The available capacity of a manufacturer of discrete goods is, in many instances, difficult to define due to the fact that goods may differ in their respective unit of measure; however, they may use the same resources. Available capacity

should be measured in a term that would ignore the product mixes such as "tons per week" or "dollars per week." Thus, the discrete items can be measured at the input side in terms of resources that are used in the manufacturing process. Available capacity can be stated in man and/or machine time per time period. A production schedule or a capacity planning system should convert required capacity per unit item into required capacity per unit of time, making it comparable to the available capacity.

Forms of Capacity

Several forms of capacity exist for a work center. These are maximum, normal, and demonstrated capacity (Wemmerlov 1984). The maximum capacity is assumed when a company operates 24 hours a day, 7 days a week. Anything in between (normal/demonstrated) is less than the maximum. The normal capacity is the capacity that would be available under normal circumstances (i.e., capacity is the maximum available capacity under normal situations).

In the real world of manufacturing, many events will occur that prevent all of the available normal hours from being used for productive purposes such as lack of material, changing schedules, machine breakdown, absenteeism, scrap rework, etc. The measure of historical use of a work center's productive hours is called demonstrated capacity. Available capacity is, therefore, measured using average past available capacity. It should be pointed out that there is a potential danger in letting the demonstrated

capacity represent the planned available capacity for the future so one must be careful when using it since the historical capacity might not have been performed under the best conditions or the highest efficiency.

Available capacity is measured in hours. However, since we are only interested in the productive use of manufacturing resources, only productive hours are used in the capacity planning process. This means that the hours available per day must first be adjusted because of allowance for machine breakdowns, absenteeism, reworks, and other losses of time.

This is called utilization factors and is expressed as follows:

$$UF = ADH/TSH$$

where:

UF = utilization factor

ADH = actual used direct hours in a given period

TSH = total scheduled hours for the same period

The utilization factors are expressed in percentage and derived from historical data for each work center (Blackburn 1984). Secondly, the available hours must also be adjusted by the efficiency factor. Due to normal variations in skills and speed, different operators can produce the same items (learning curve).

This can be calculated as the standard direct labor hours earned by a work center based on the shop orders worked in a given period of time divided by the actual direct labor applied in the work center to produce the same orders (Blackburn 1984).

$$EF = SPH/ADH$$

where:

EF = efficiency factor

SPH = standard hours processed in a given period

ADH = actual used direct hours in the same period

CHAPTER II

BASIC COMPUTATION USED IN CAPACITY PLANNING

To calculate the required capacity of the planning horizon, one needs to find the adjusted available capacity for each work center. Hence, the lead time required for producing an item is easily found by multiplying the standard process time (including inter-operation time) by the order quantity. Then, divide the results by the adjusted capacity. The procedure will be explained in the next two sections.

Calculation of Capacity

Calculation of capacity is best explained through an example. Consider a work center with one employee per shift. In an eight hour, two-shift operation, with a utilization factor of 80% and an efficiency factor of 105%, the total expected number of standard hours that can be produced per day is adjusted capacity, as shown in Figure 1.

Thus, the required capacity for the work center for period (i) can be found as follows:

$$RQ_i = N_i * T_j$$

where:

RQ_i = required capacity for period i

N_i = number of scheduled units for period i

T_j = standard time for operating j/unit

2 shifts x 8 hrs/day = 16 available capacity/day

times 80% utilization equals

12.8 actual direct labor hours/day

times 105% efficiency equals

13.7 standard direct hours/day

Figure 1. Converting available capacity to standard capacity.

Calculation of Lead Time

The lead time is defined as the elapsed time between the start time of the operation to its finish time. To calculate the lead time, we need to establish the standard time for each operation which should include elements such as:

1. Queue time (Q) -- average time before or after processing which is the average time spent while waiting in a work center before the work on the order can be stated or moved to the next work center.

2. Set up time (S) -- the time required to set up the work center for the run.

3. Standard run process time (R) -- the number of standard labor hours required to produce one unit in a work center assuming no learning process exists.

4. Move time (M) -- the average actual time required to move a standard lot of material from one preceding work center to the next.

Figure 2 illustrates the overall operational time.

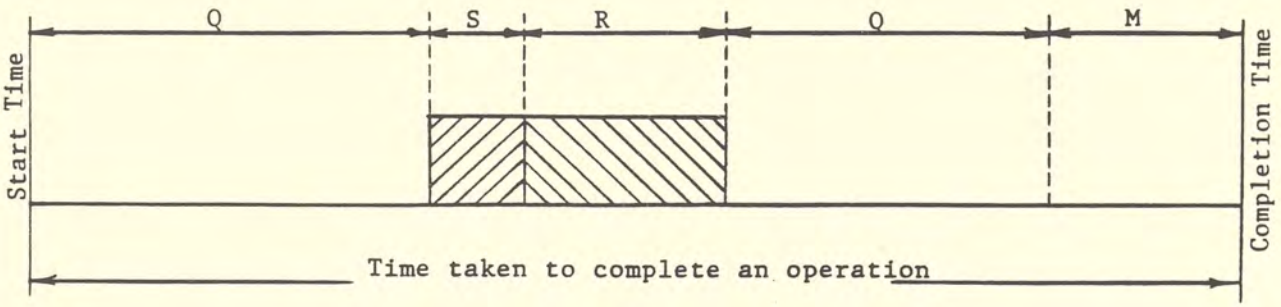


Figure 2. Overall operation time.

Lead time can be calculated as:

$$LT = Q/(UF * T) + S/(UF * EF * A) + (R * OQ)/(UF * EF * A)$$

where:

LT = lead time

Q = actual queue time

UF = utilization factor

T = average daily time

EF = efficiency factor

OQ = order quantities

A = available daily hours

R = standard run time/unit

Based on the time required to carry out all operations required for certain products, the total manufacturing lead time in terms of actual operation times and inter-operation times for all required operations (shown in Figure 3), can be determined and used for calculating the date in which work must start.

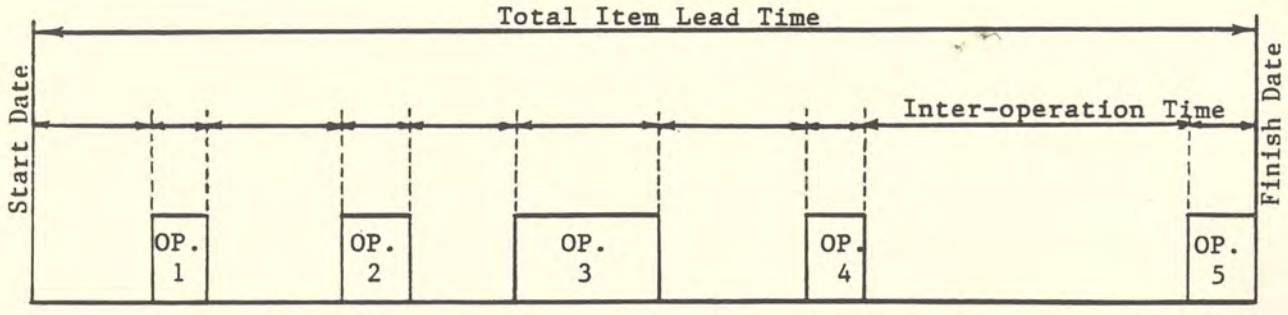


Figure 3. Total manufacturing lead time.

CHAPTER III

CAPACITY PLANNING TECHNIQUES

Capacity planning systems are often confused with the related operation scheduling and sequencing systems. An operation's scheduling system is concerned with short-term problems such as the jobs to work in, which operations should be performed on a given day, and the relative priorities of various jobs. Capacity planning system is not concerned with individual jobs, but rather it relates the total load on a given work center for each period of time along the planning horizon.

It is impossible to identify a single specific technique with a specific level of schedule or level of planning and control for all manufacturers. One manufacturer, for example, might use a detailed operation schedule and weekly period loading system to capacity management as it relates to the production plan. Another manufacturer might find this impractical because of the data required and data processing volumes, and instead utilize resource load profile simulations.

Each of the capacity planning techniques is done at different levels of production planning with a different planning horizon and degree of detail. Hence, several of these techniques might be used in the same company (i.e., a company might use the less

detailed technique in the long-term and the detailed technique for the short-term planning). Figure 4 illustrates the different type of capacity planning techniques with respect to the degree of detail and planning horizon length.

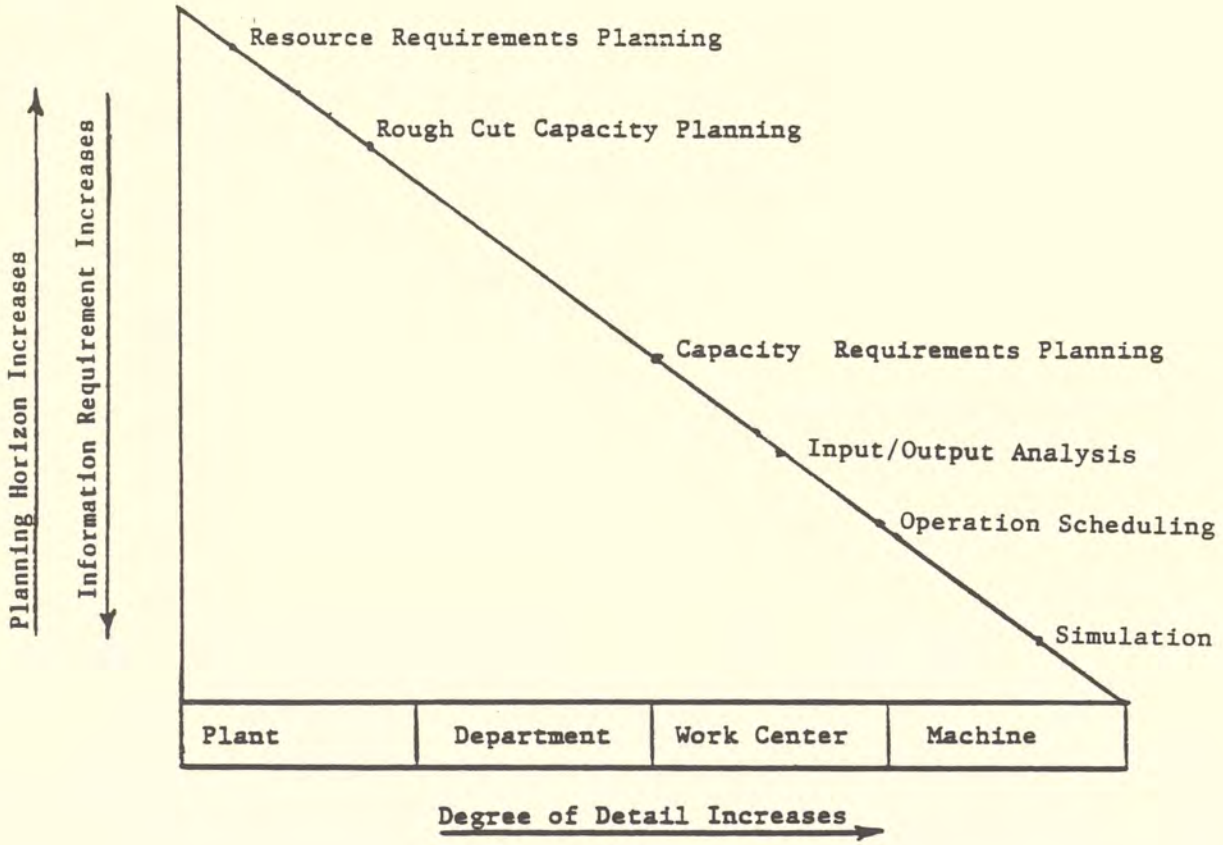


Figure 4. Relationship between planning horizon planning period, application area, and various techniques.

Thus, from Figure 4, capacity planning techniques can be categorized according to the length of the planning horizon in two main groups, as follows:

1. Medium-to-long range techniques

    a. resource requirement planning
    b. rough cut capacity planning
    c. capacity requirement planning

2. Short range techniques

    a. operation scheduling
    b. input/output control/analysis
    c. simulation

The decisions regarding which technique should be used is very much dependent on the desire and need of the company. Each one of these techniques differ from the others in degree of detailed requirements for information, length of the planning horizon, length of the planning period (time bucket) and revision frequency.

The medium-to-long range planning techniques are discussed in this chapter and the short-term planning techniques are discussed in the next chapter.

Resource Requirement Planning (RRP)

Resource requirement planning is the process of determining long-range resources or capacity need (Wemmerlov 1984). The resource planning horizon is at least as long as the lead time to acquire the resource (the RRP performed in connection with the making of the production plan).

The characteristics of this type of capacity planning is that the production schedule is stated in aggregate units, the planning horizon is fairly long (1-3 years), the planning period is often a

month or quarter of a year, and the frequency of revision can vary from monthly to annually. Also, the planning is mostly done for the plant as a whole or for smaller organizational units like fabrications and assembly departments.

The RRP will warn management of needed capacity expansions or contractions. Building a new facility can take a long time and deliveries of new equipment can take over a year. In this case, capacity expansion manpower hiring or training might be as long as installing the new facilities. In the case of capacity reduction, lay-offs should be planned carefully due to its negative effects on the moral of the employee.

The planning techniques normally used for RRP are the capacity planning factors, bill of capacity, and time-phased bills of capacity. In this section, only the capacity planning factors will be discussed.

Capacity Planning Factors (CPF)

The CPF is a relationship between one unit of production and a resource used in the manufacturing process (Wemmerlov 1984). The purpose of CPF is to convert a production schedule into an estimated usage of the resource. The resource in question can be man-hours, machine hours, floor space, engineering design hours, raw materials, etc.

The CPF is different from other techniques in that the relationship between one unit of a production schedule (or a

forecast) and the resource is found indirectly. Instead of determining the resource content of each scheduled unit and extending the production plan by this number, the approach is to relate historical output to a historical input using this relationship as planning tool. The process can best be explained by assuming the following case. A production facility can be grouped into four major areas: first stage operation, second stage operation, finishing, and assembly. One product line (family) consists of six different product models, and over the last four months 52,000 direct man/machine hours were recorded in these areas for the products and 6,500 units were produced. The company's production plan is stated in aggregated units of products with each one representing a product's family. The production plan calls for 7,500 units over the next three quarters. An estimate of the required capacity can be performed as shown in tables 1 and 2. The 52,000 man/machine hours recorded the last four months were distributed as shown in these tables.

Management can compare the projected future capacity over the next three quarters to the available capacity (using standard hours). It can then change its production plan or expand the capacity if the project capacity is more than what is available. It might be worth noting that the allocation of standard hours over the manufacturing areas might vary with the production of each model in the product line (family). Hence, a changing product mix will affect the accuracy of the capacity projection.

TABLE 1

CAPACITY PLANNING FACTORS BASED ON HISTORICAL ALLOCATIONS OF MAN/MACHINE HOURS

PRODUCTION STAGES	STANDARD HOURS	PERCENT OF TOTAL HOURS	HOUSE PER UNIT
Primary Stage	14,000	26.92*	2.154**
Secondary Stage	23,000	44.23	3.538
Finishing	5,500	10.58	.846
Assembly	9,500	18.27	1.462
	52,000	100	8.0

* 26.92 = (14,000/52,000) x 100

** 2.154 = (14,000/6,500)

TABLE 2

RESOURCE REQUIREMENT USING CPF

PRODUCTION STAGE	UNIT REQUIRED	REQUIRED CAPACITY (STANDARD HOURS)
Primary Stage	7,500	7,500 x 2.154 = 16,155
Secondary Stage	7,500	7,500 x 3.538 = 26,535
Finishing	7,500	7,500 x 0.846 = 6,345
Assembly	7,500	7,500 x 1.462 = 10,965
		TOTAL HOURS: 60,000

Advantages and Disadvantages

Planning factors have the following advantages and disadvantages.

Advantages

1. They are easy to produce, fast and simple to apply, and easy to understand by management.

2. Capacity requirement projections are linked to production schedules. This facilitates revisions of the production plans.

3. If standard hours do not exist, actual direct hours can be used (as in Table 2).

Disadvantages

1. Capacity planning factors are sensitive to future changes in the product mix as well as the technology of manufacturing. The execution of a production plan, in which a product mix is different from the one in which the CPFs were based, can generate actual capacity that deviates from the project capacity.

2. Capacity planning factors do not consider lead time or inventory.

Rough Cut Capacity Planning (RCCP)

Rough cut capacity planning (RCCP) is an analysis of the master schedule to assist in evaluating capacity requirements for critical manufacturing facilities or a specific work center (Wemmerlov 1984). The RCCP is associated with the master production schedule and often uses the same techniques as RRP but

with different degrees of detail (capacity requirement per work center), different frequency (monthly revisions), different lengths of planning horizon (6-18 months), and employs weekly time buckets.

RCCP gives the planner a first "cut" as to what the resource requirements picture looks like should the master schedule be implemented. Bills of capacity techniques (B/C) will be used to explain the RCCP since we have explained the CPF in the previous sections.

Bill of Capacity (B/C)

The bill of capacity (B/C) is a document similar to a bill of material (Wemmerlov 1984). While the bill of material lists the material that goes into a manufactured item, the B/C specifies the standard time needed to manufacture the same item as well as the location (work center number) where the processing takes place inside the plant. The B/C for a master scheduled item is easily constructed with the information from the bill of material and routings file (list of the sequence of operation and work center in which these operations are processed for the item in question). The B/C can be calculated manually using estimated time and might include only the critical work centers. It may be constructed with computerized methods by utilizing the typical product structure and the standard time on the routings file. The logic for calculating the product B/C is:

1. Process each part in the product structure on a level-by-level basis.

2. For each part, retrieve the standard time from routing file.

3. Extend the run time by the quantity and the lot size.

4. Add the set up time.

5. Summarize the hours by work centers.

Example

Consider product X whose structure is shown in Figure 5. The numbers in parentheses represent the quantity per the parent item.

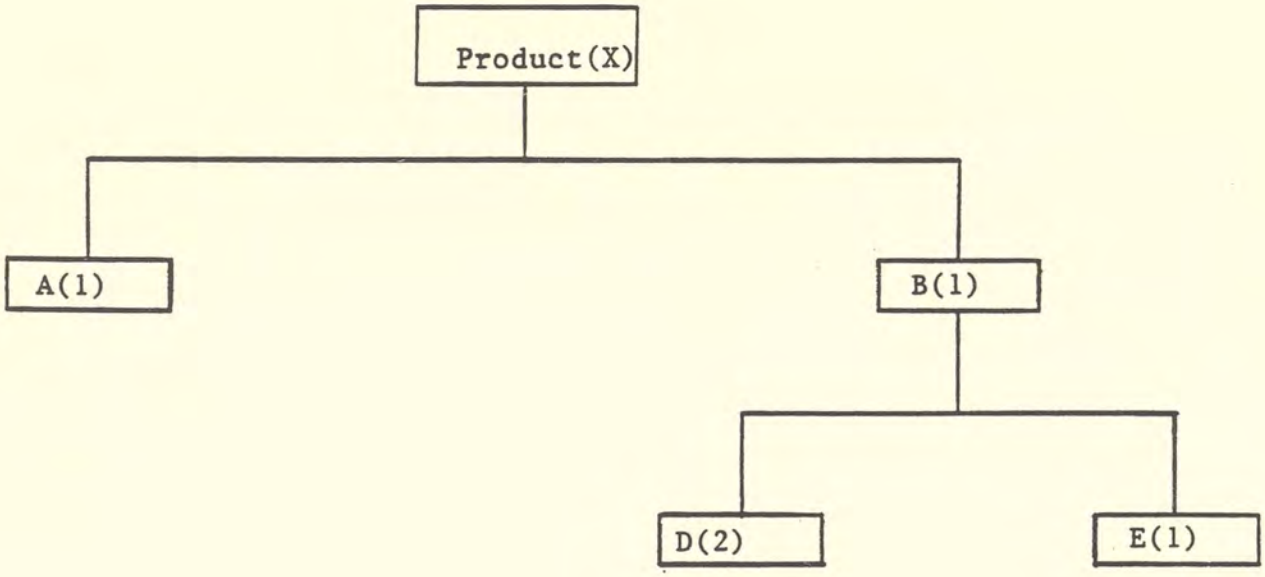


Figure 5. Product X structure.

The routing for each of these plots is shown in Table 3. Then, Table 3 can be totaled by work center to give the bill of capacity per work center, as shown in Table 4.

TABLE 3

ROUTING INFORMATION FOR PRODUCT X

PART	OPERATION NUMBER		WORK CENTER NUMBER	RUN TIME/ UNIT	SETUP TIME	AVG. LOT SIZE	SETUP TIME/ UNIT	TOTAL TIME UNIT
A	01	Mill	10	.09	.40	40	.010	.100
	01	Grind	15	.05	.20	40	.005	.055
	03	Inspect	50	.02	.30	40	.007	.028
D(2)	01	Saw	11	.02	.20	40	.005	.025
	02	Lathe	20	.03	.02	40	.001	.030
	03	Mill	10	.08	.40	40	.010	.090
	04	Grind	15	.05	.20	40	.005	.055
	05	Inspect	50	.02	.30	40	.007	.028
E	01	Saw	11	.04	.30	50	.006	.046
	02	Mill	10	.05	.40	50	.008	.058
	03	Grind	15	.06	.20	50	.004	.064
	04	Inspect	50	.04	.40	50	.008	.048
B	01	Assemble	5	.05	.04	40	.001	.051
	02	Inspect	50	.02	.02	40	.001	.021
X	01	Assemble	5	.06	.05	40	.001	.061
	02	Inspect	50	.02	.02	40	.001	.021

TABLE 4

BILL OF CAPACITY FOR PRODUCT X

WORK CENTER NUMBER	RUN TIME/ UNIT	SETUP TIME/ UNIT	TOTAL TIME/ UNIT
5	.11	.02	.13
10	.30	.04	.34
11	.08	.02	.10
15	.21	.02	.23
20	.06	.01	.07
50	.11	.02	.13

The required number of standard hours from a given master schedule is determined by multiplying the scheduled quantity for each period of the end item by the respective bill of capacity (see Table 4). Using the master schedule for Product X, as in Table 5, will generate the capacity plan in Table 6. The master schedule is stated in terms of production start dates for the final operation, not in terms of due dates.

TABLE 5

MASTER SCHEDULE FOR PRODUCT X

WEEK:	1	2	3	4	5	6	7	8	9	10
Master Schedule	30	25	20	25	35	25	25	30	30	30

TABLE 6

CAPACITY PLAN IN STANDARD HOURS
USING THE B/C TECHNIQUE

WORK CENTER NUMBER	WEEK									
	1	2	3	4	5	6	7	8	9	10
5	3.9	3.25	2.6	3.25	4.55	3.25	3.25	3.7	3.9	3.9
10	10.02	8.5	6.8	8.5	11.9	8.5	8.5	10.2	10.2	10.2
11	3	2.5	2	2.5	3.5	2.5	2.5	3	3	3
15	6.9	5.75	4.6	5.75	8.05	5.75	5.75	6.9	6.9	6.9
20	2.1	1.75	1.4	1.75	2.45	1.75	1.75	2.1	2.1	2.1
50	3.9	3.25	2.6	3.25	4.55	3.25	3.25	3.9	3.9	3.9

Advantages and Disadvantages

The bill of capacity has the following advantages and disadvantages.

Advantages

1. They are simple to create and store. Once they have been made, they can be used repeatedly to the different master schedule. The B/C needs to be updated if any of the information on which they rely on are changed (routing, run time, etc.).

2. They can be made only for critical resources (work centers) so that bottlenecks can be identified and monitored.

3. They create a direct link between the master schedule and the capacity requirements at the work center. Therefore, any undesirable overload or underload can easily be corrected by manipulating the master schedule.

4. It is a good sensitivity tool in which management can play "what if" analysis, with different master schedules since it is an easy and fast technique for evaluating the capacity requirements.

Disadvantages

1. In a short planning period (time buckets) and long lead times, the timing of the capacity requirements is less accurate since it ignores the lead time.

2. Work-in process or finished parts are not considered during the planning process, the result will be an overestimated load.

3. If the lot sizes for a master schedule are different from these used to create B/C tables, the estimation of the setup time requirements can be misleading. Changing the lot sizes from one master schedule to another is likely to happen.

Capacity Requirement Planning (CRP)

The capacity planning techniques previously discussed translate a production schedule for end items or groups of end items into capacity requirements on the work centers. The majority of work centers from which capacity requirements are estimated do not process the end items but rather the parts that make up the end items. Hence, a more detailed technique for capacity planning depends on order schedules related to manufactured parts and not only on the master schedules and

production plans. Namely, this refers to capacity requirement planning techniques.

CRP is the determination and future projection by time periods and work centers of the required capacity for a facility if a given amount of orders are to be delivered.

CRP consists of order scheduling and work center loading. This is often referred to as infinite loading since capacity is not considered in the scheduling or the loading. The CRP uses a weekly planning period (time bucket), and planning horizons from two to six months. This is adequate for medium-term horizon. Occasionally, CRP can also be used for a longer horizon. For example, the case with the companies that do not use RCCP procedures, but rely instead on the CRP technique for medium- and long-term capacity planning. The CRP can be updated more frequently than can RCCP (usually on a monthly or bi-monthly basis).

Required Capacity Calculations Using CRP

The input to the capacity planning system, consisting of planned and released orders, is normally planned by MRP from the master schedule. (Usually, the MRP will time phase and lot size these orders.) Also, the required operations are loaded by reference to the routing file. This also shows the work centers from which the individual operations are carried out. Each operation setup time, run time, average queue time, and the time

required to move standard lot size to the next work center are also included in routing file. The information related to the work center capacity (normal, maximum), efficiency factor and utilization factors are stored in the work center's file which can be used in calculating the lead time and required capacity. In some cases, if an alternative work center can do the same work, the information should be included in the work center's file. The CRP uses the work shop calendar instead of the normal calendar, although the two are interchangeable.

The CRP uses the forward scheduling process in which the orders are scheduled to start on the current date if no starting is specified. The sequence of operations is loaded onto the relevant work centers which take into account the process, queue and transmit time for each operation. The alternative scheduling process is the backward scheduling which is based on the assumption that all items will be delivered on their due date. The time taken to carry out the last operation is loaded onto the appropriate work center and the start date for the final operation is calculated. Once again, the queuing process time and transmit time are fully taken into account. The same procedure is repeated for all the operations on the routing file which must be performed to manufacture the item. Usually, backward scheduling is recommended for CRP. Figure 6 illustrates the forward and backward loading principles.

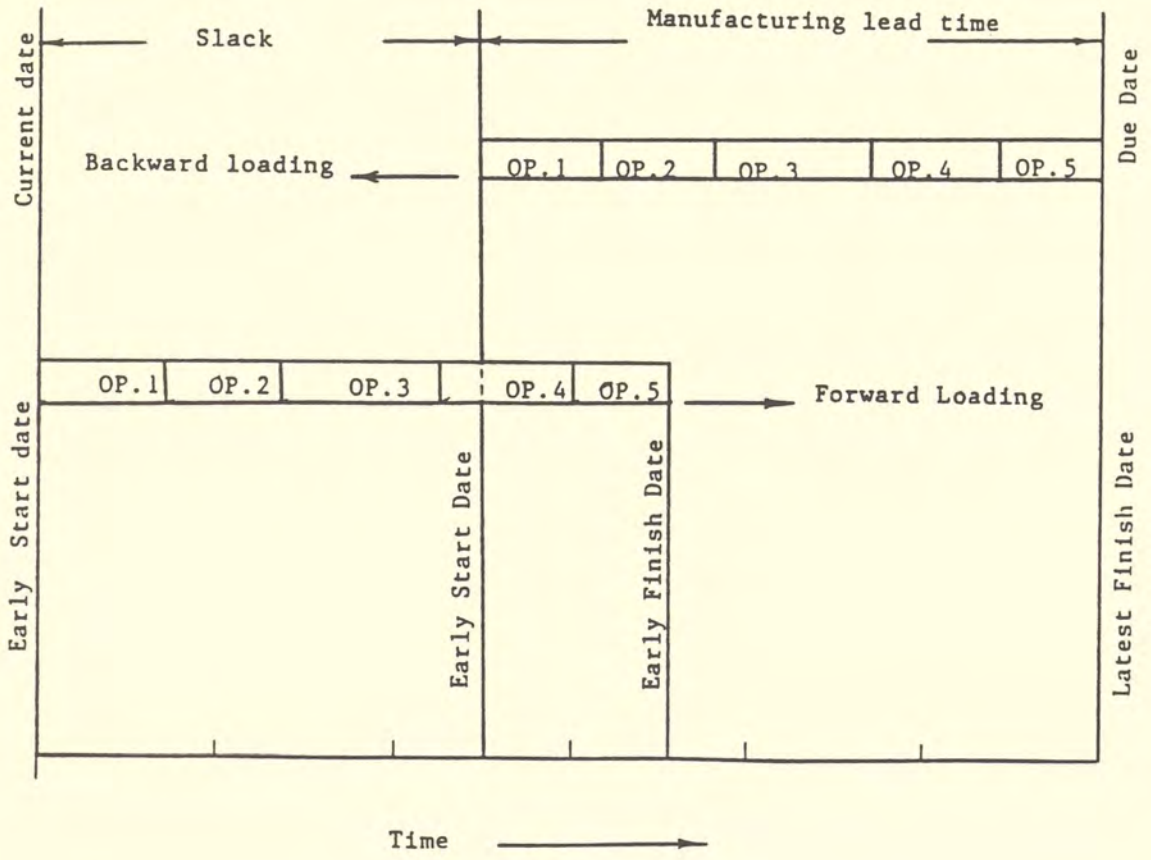


Figure 6. Forward and backward loading.

If the latest start date is before the current date or the order starting date, it is necessary to reschedule the order in forward direction from the current or starting date and a new due date must be calculated. A special report should single out these orders.

The slack or delay associated with an order can be calculated after it has been scheduled. If forward scheduling is employed, the slack is the time available between the calculated earliest

finish date and order due date. In backward scheduling, the slack is the time available between the current date or start date and the latest start date. Also, the delay is the time between the earliest finish date and due date in forward scheduling; whereas in the backward, the delay is the time between latest start date and current or starting date. In case of a delay, the management might try reducing the inter-operation times, or order splitting, and/or overlapping. Figures 7 and 8 show the delay and slack in backward and forward scheduling, respectively.

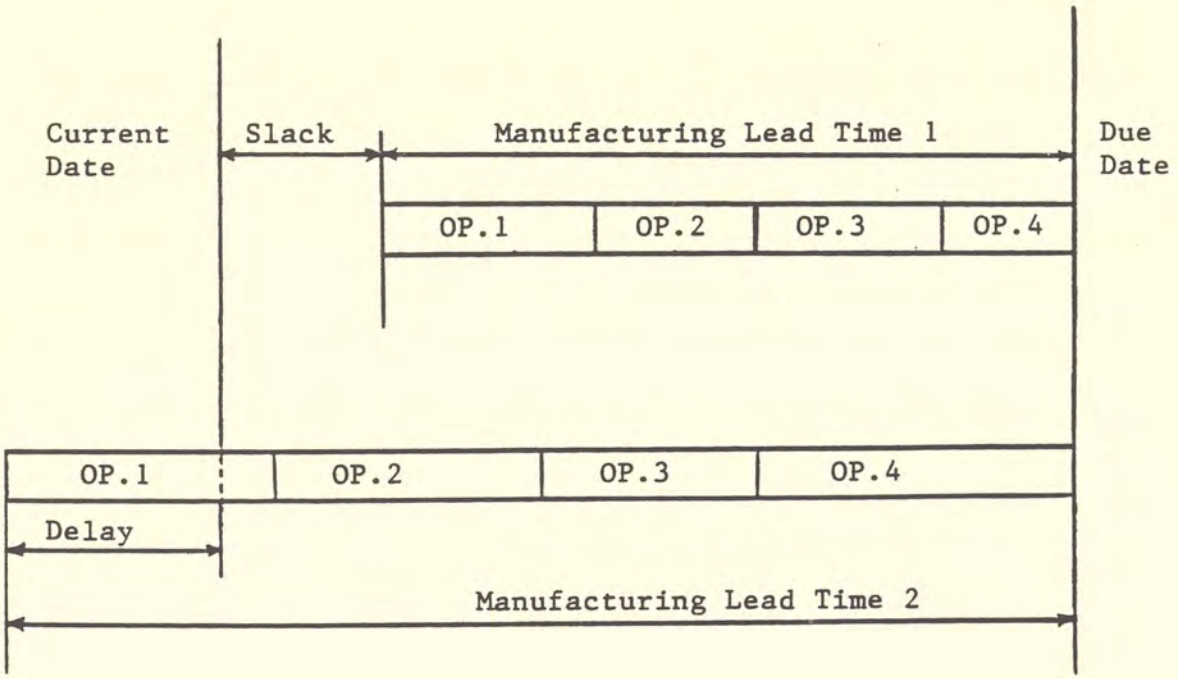


Figure 7. Delay and slack in backward scheduling.

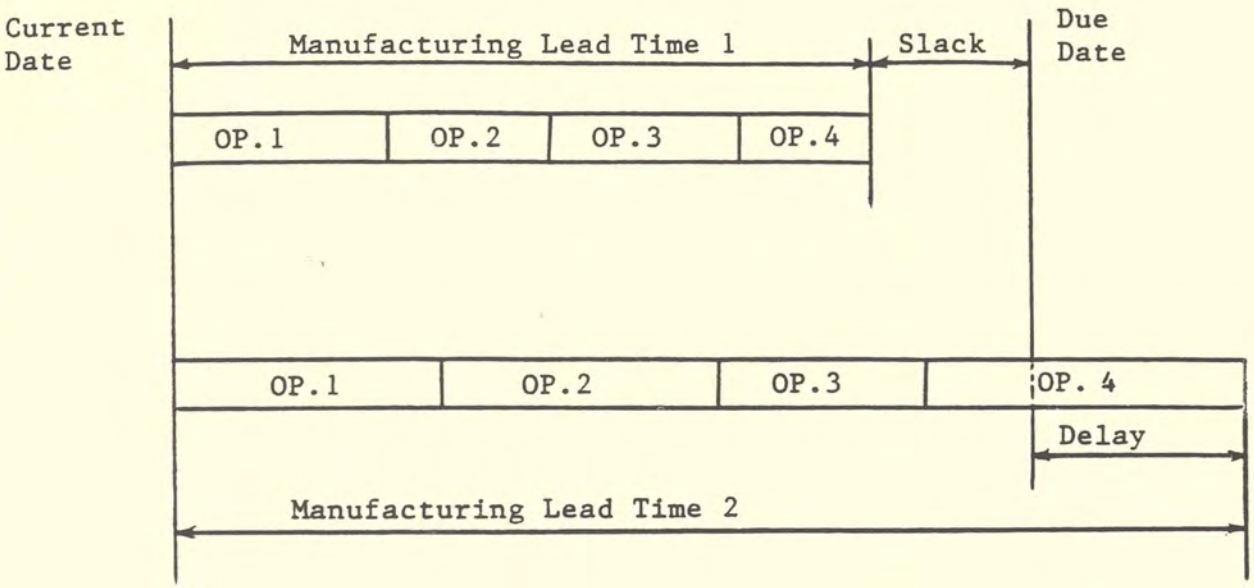


Figure 8. Delay and slack in forward scheduling.

A typical work center capacity load profile report, showing the underloading and overloading of the work center along the planning horizon is shown in Figure 9.

Advantages and Disadvantages

CRP has the following advantages and disadvantages:

Advantages

1. It is the most detailed technique for translating manufacturing order schedules into time-phase capacity requirements.

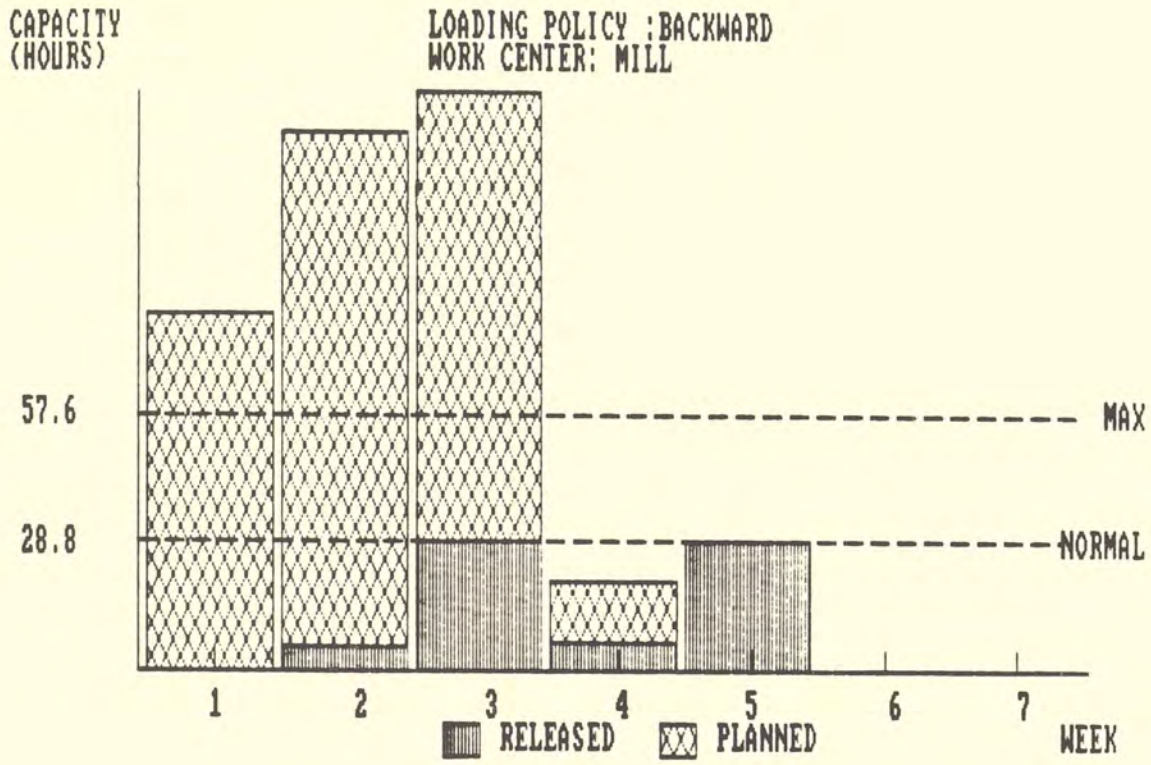


Figure 9. Typical load profile report.

2. On-hand and work-in-process will reduce inventories. This will reduce the total capacity needed to execute the master schedule.

3. It uses actual lot size. This leads to a more accurate estimation of run times and setup times at each work center.

4. It uses the manufacturing lead times which result in time-phase capacity plan.

5. It adjusts the work center's rated capacity by the utilization and efficiency factor which gives a better estimate of the load status at each work center.

6. It allows management or the planner to play a "what if" type of question in order to check the feasibility of meeting the master schedule.

7. In most cases, the order schedule is generated by an MRP system. Therefore, service parts, scrap, safety stock build up, etc., can be accounted for in the capacity plan.

8. Capacity needed from reworks of parts can be accounted for by issuing new orders to the work center.

Disadvantages

The following factors can be viewed as disadvantages or at least limitations of the CRP.

1. CRP must be computerized due to the amount of information involved.

2. The computational effect is great, especially if a modification is made to any of the data (order file, routing, file, etc.).

3. The generated capacity plan has a restricted link to the master schedule which is a direct result of parts commonality (some parts appearing in several end items), lot sizing, and time phasing. If under load or overloads occur, when compared to available capacity, changes in the master schedule will lead to unpredictable alterations in the capacity plan. However, it is possible to keep track of planned CRP for each work center. This way, one cay separate the hours which emanate from planned and released orders and also identify the order number associated with

each input. Such detail will allow the planner to smooth the capacity plan by releasing the order early or late, or rescheduling an already released order.

4. The total accuracy of the load over the extended period of time depends primarily on the reliability of the time standards.

CHAPTER IV

SHORT RANGE CAPACITY PLANNING TECHNIQUES

The short-term capacity planning techniques, sometimes called "finite" load techniques, are where the work centers are loaded to their capacities. Hence, they do not forecast the future capacity requirement, but can be used to detail a list of the sequence of operation or jobs to the shop floor. Also, they can be used to monitor and control the queue length due to their effect on the orders' deliveries (meeting due dates).

Operation Scheduling (OS)

OS is the short range scheduling and loading techniques which consider finite capacity availability (Clark 1984). The OS technique should help manage release of orders into the shop and provide a priority controlled leveling of loads and realistic dispatch list.

Scheduling to "infinite" capacity (CRP) and scheduling to "finite" capacity are not mutually exclusive. For example, CRP and OS can work well together. CRP, and other capacity estimating techniques, can first be applied in order to ensure that capacity is available, on the average, to meet the master schedule in medium to long range. In the short range (2-3 weeks), OS can be

used to simulate the manufacturing activities and generate schedules for the tool requirement, labor skills and machine hours. The OS appears in the literature under various names: Finite Capacity Planning, Finite Loading, and Operation Scheduling.

An OS is a detailed simulator of shop floor activity that takes the planned and released orders and schedules each order's operation onto the machines where they will be processed. The OS has to be computerized due to the mass of calculation, searching, and sequencing that needs to be done in order to initiate the stream of jobs flowing through the factory. The factory is represented by a model consisting of the various work center capacities, and each job is represented by its routing and time requirements. Rules of the computer simulation process should be duplicated to show ways in which various contingencies are handled on the shop floor. For example, rules governing precedence (priorities), order splitting and overlapping, transit time, and other functional and decision-making aspects of production control are built into the system (i.e., operations are processed in priority sequence against available capacity in each work center). Using setup, run and transit time, the start and finish time of each job is estimated. The highest priority jobs are given first claim on open capacity as they would occur in the shop. Various priority rules can be used such as critical ratio, shortest process time, and slack rule. Thus, high priority jobs encounter

short queue while less priority jobs might experience longer waiting time on heavily loaded work centers. In this way, queue lengths are simulated in advance and can be considered during planning.

Advantages and Disadvantages

OS has the following advantages and disadvantages.

Advantages

1. Start and completion dates for operation can be estimated without relying on average queue time when scheduling operations.

2. Queue time can be calculated for each work center or machine based on simulated activities on the shop floor. This will make estimates of finish dates more accurately.

3. Priority lists for job ranking can be established from the dispatching list that has been generated by the OS which helps foremen processing the jobs.

4. Bottleneck resources can be identified. A machine or work center is fully scheduled over the planning horizon for which queues are building up, and represents a bottleneck machine so corrective action must be taken.

Disadvantages

1. It requires more input data than any other technique and utilizes fairly complex scheduling algorithms. For OS, scheduling is done at the individual machine level. Thus, the computational effort involved is usually high.

2. It has been argued that there are difficulties connected with the determination of the capacity that is actually available at the machine. This difficulty is due to the fact that labor is movable, and the unpredictable events, like machine break-downs and absenteeism, cannot be planned. Scheduling the capacity must be fixed.

Input/Output Control Technique (I/O)

The I/O technique is both a planning technique and a capacity control technique. A typical I/O report for a work center is shown in Figure 10.

Week	4	5	6	7	8	9
Planned Input	60	70	75	80	95	100
Actual Input	50	75	80	75		
Cum. Dev.	-10	-5	0	-5		
Planned Output	80	70	90	85	95	100
Actual Output	90	80	80	80		
Cum. Dev.	+10	+20	+10	+5		

Figure 10. I/O typical report.

The planned input is the most critical element and the most challenging to manage. Usually, it is taken from the CRP, wherein the planned output is an estimate into the near future from the work center foreman. It is based on his/her knowledge of machine

and worker capability, availability, and job characteristics. The actual input and output are measured values. Accurate and timely shop reporting is essential. The actual output establishes the true available capacity of a work center.

Actual input and output will have some variation so the cumulative deviation is monitored as well as period deviation. This provides the first indication of whether or not a work center has an input or output problem. Cumulative deviation is monitored relative to a specified limit. Action should be taken when the limits are exceeded.

Problems in input force the examination of upstream work centers, or the orders release system in the case of primary work centers.

The input to secondary or intermediate work centers and final assembly are more difficult to control because input load is coming from multiple sources. Problems in the output are problems with capacity (unless they are the direct result of input problems and the solution of the output problems is an effective capacity planning system).

The rate at which new jobs, and thus, standard hours to be processed, arrive at a work center can, to a certain degree, be regulated. This input to work center is adjusted by delaying the order release suggested by material requirement planning system, or by pulling orders ahead of time. It is also possible to adjust the output rate in the short-term for a work center by scheduling

overtime, alternate work centers, and subcontracting. The I/O report can be looked upon in two ways. It is, on one hand, a vehicle for displaying actual flows of input and output of standard hours to work center from which this actual queue can be derived. It is also a planning tool that is useful in connection with short-term decisions or capacity levels and order releasing. Input/output monitoring and control is as useful in production planning and master production scheduling as it is in supporting the management of individual work centers. The I/O is a method by which both capacity requirements and available capacity can be determined for the near future.

Advantages and Disadvantages

I/O control has the following advantages and disadvantages.

Advantages

1. It helps control capacity by regulating the input or by increasing the capacity to the needed planned output.

2. It focuses on stabilizing the planned queue or backlogging as the primary capacity planning objective.

3. I/O planning offers more flexible alternatives to the capacity planner by giving him visibility as to future input, future output, and future queue variations by time period.

4. Changes to planned lead times are easier to implement with I/O planning. This will show the results clearly in terms of queue variations by time period.

Disadvantages

1. The use of the historical to make a decision about the future is questionable.

2. I/O reports can be generated by the CRP, so decisions can be made based on CRP as can be made in I/O.

3. I/O is capacity oriented and not oriented towards orders, so delaying of orders is hard to anticipate.

4. The effect of increasing or decreasing a capacity of work center on the next work centers are not immediately visible in the I/O.

Simulation

Most of the previously mentioned techniques were simulation techniques, but they are less sophisticated forms of simulation. In the computer, the stream of jobs flowing through the factory in the future is imitated. The factory is represented by a model consisting of the various work center capacities; each is represented by its routing and time requirements. The rules of the computer simulation process duplicates, as closely as possible, the ways in which various contingencies are handled on the shop floor; for example, rules governing procedures, order splitting and overlapping, and transit time.

A more sophisticated simulation technique can also be employed to get very accurate analyses of the work shop environment and dynamics of the situation. Sometimes this

technique is referred to as "vertical loading" in which it considers all operations of all jobs and moves from job to job loading the highest operation which is available at each encounter of available capacity. There are several ways this can be accomplished by the computer.

In one method, all operations of all jobs are separated by work center and arranged in queue according to their priority. A master clock advances by increments of time and at each advance, all machines are polled for available capacity. If an open capacity is found, the queue of the available center is scanned for a job which is ready at the master clock time. The job is assigned to the machine and the machine clock is set to the finished time. The next operation of that job is tagged with its ready time. The machine's capacity, breakdown, and order lead time are also simulated to the real situation by finding their distribution from the historical data.

An alternative method sequences all jobs and their operations in priority sequence and constructs an event chain which is maintained (the operation) in the order of occurrence. If an event (job completion) is selected, the clock is advanced to that time and finish time recorded. The succeeding operation of that job is then placed in queue in its machine. The next operation in queue at the machine is selected and loaded. Its finish time is calculated and it is placed in the event chain in its chronological order (Clark 1984).

The sophisticated simulation techniques are not very popular due to the mass of data needed and generated by the system which is very costly in terms of computer time. Also, it is very costly in terms of analyst time. Although more accurate data and more detail can be obtained from this technique, the cost might not be justified in most cases.

CHAPTER V

CAPACITY PLANNING - MICROCOMPUTER SYSTEM

Presented in this chapter is a computerized capacity planning system for the IBM microcomputer family. The system maintains the profile of the job shop in a data base along with the data pertinent to various products that can be manufactured in the shop. The system has its own data base management component which is used in creating, updating, and modifying the data base contents.

System Description

The system is composed of three components:

1. Data base management (DB management)
2. Working algorithms
3. Graphical representation

Figure 11 is a schematic block diagram for the system and its components.

The data base management has the function of creating and updating the system's files. Five files make up the system's DB. These are:

1. Company file
2. Product file
3. Work center file
4. Release orders file
5. Planned orders file

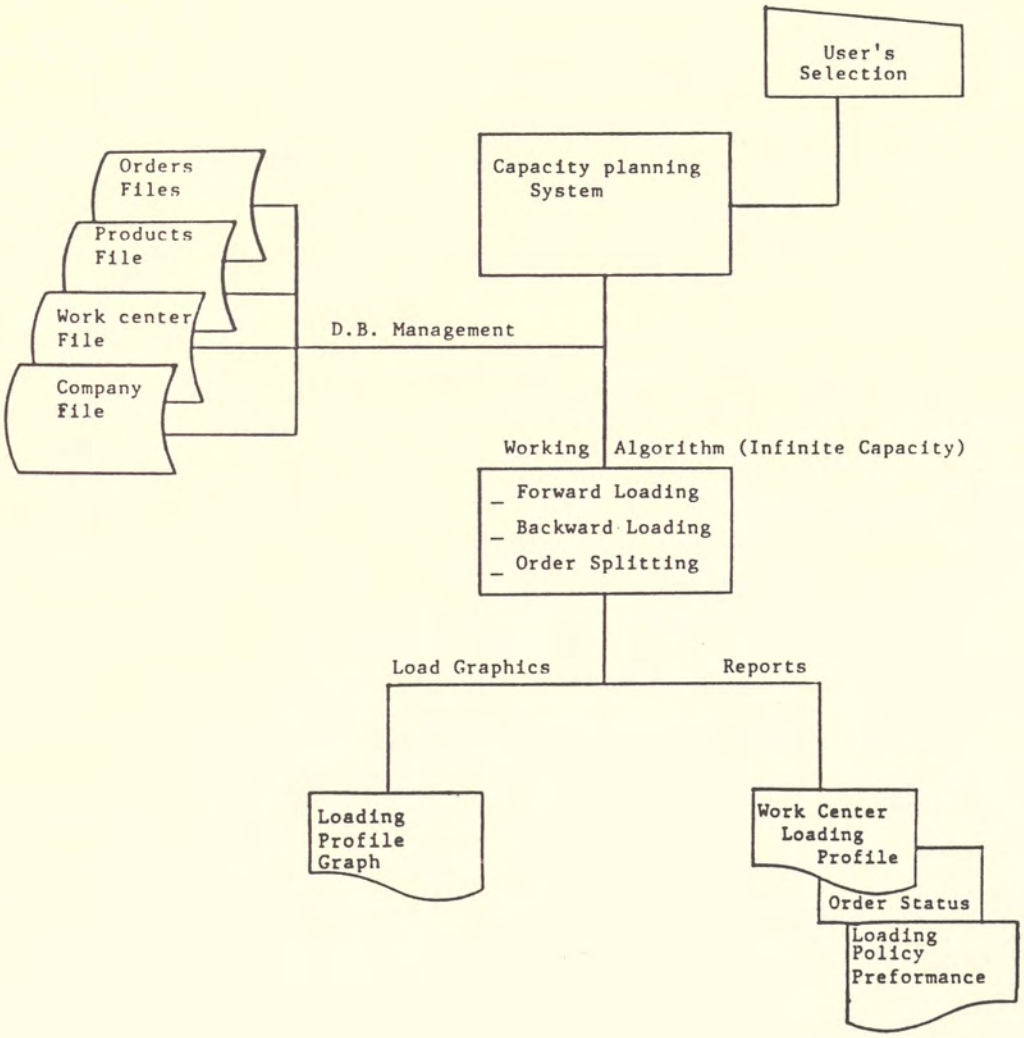


Figure 11. System block diagram showing system components.

Figures 12 through 15 are the record layout and contents of each of the files. File types are compatible with the system with respect to the accessibility. The data base management component in the system is accessed by selecting the component from a system's menu of options which is displayed to the user at the beginning of system run (option #3 and #4). Selection of this option will direct the user to secondary menus pertinent to creating/updating any of the system files. Creating of the files is done through a questions/answers dialogue with the user, where the contents of each record are verified and approved by the user before they are added to the file. Updating the files includes adding new data, deleting data, and modifying current data.

COPMANY FILE HAS THE FOLLOWING INFORMATION :

1- COPMANY NAME : XYZ		
2- NO. OF PRODUCTS (=< 10)	:	3
3- NO. OF WORKING CENTERS (=< 10)	:	5
4- NO. OF WORKING WEEKS IN A YEAR	:	52
5- NO. OF WORKING HOURS IN A DAY	:	8
6- NO. OF WORKING DAYS IN A WEEK	:	5
7- NO. OF WORKING DAYS IN A MONTH	:	20

Figure 12. Company file record layout and contents.

PRODUCTS FILE

PRODUCT NO. : 1 PRODUCT NAME : PP1

SEQUENCE OF WORK-CENTERS (OPERATIONS)	PROCESS TIME	1ST ALT. WORK CENTER #	1ST ALT. PROCESS TIME	2ND ALT. WORK CENTER #	2ND ALT. PROCESS TIME
1	.01	0	0	0	0
2	.15	0	0	0	0
3	.02	0	0	0	0
4	.04	0	0	0	0
5	.05	0	0	0	0

Figure 13. Product files record layout and contents.

WORK-CENTERS FILE

W.C. NO.	WORK-CENTER NAME	NOR. CAP.	MAX. CAP.	EFF. FACT.	UTIL. FACT.	OPERATIONAL COST / HR. IDLE	(> MAX)	BETWEEN MAX&NOR.
1	TURN LATHE	8	16	90	80	4	10	8
2	MILL	8	16	95	85	5	12	10
3	DRILL	8	16	95	80	2	8	5

Figure 14. Work center file record layout and contents.

RELEASED ORDERS FILE

ORDER NO. 200 HAS THE FOLLOWING DATA

1- ORDER NO.	:	200
2- PRODUCT NO.	:	1
3- ORDER QUANTITY	:	150
4- DELIVERY LEAD TIME	:	25
5- STARTING PERIOD (FROM STUDY DATE)	:	0
6- ITEM EARLY FINISH COST (PER DAY)	:	.3
7- ITEM DELAY COST (PER DAY)	:	.5

Figure 15. Order file (released/planned) record layout and contents.

Other options pertinent to the data base are the system's status option -- Option #1 in the system's main menu, where the contents of the system files are displayed to the user for information before deciding on the next course of action. Figure 16 is a typical dialogue of creating the work center file. Similar dialogues are followed in creating/updating other system files.

The programs which make up the data base management component of the system are listed below and are documented the Appendix.

1. orderfil
2. compfil

The working algorithm component of the system is composed of the capacity planning program.

The capacity planning program uses the company data base, user specified loading policy, planning horizon, planning period, and time buckets to generate the required capacity for each work center along the planning horizon.

Once the program is executed through the choice of option #4 of the system main menu, the user will be prompted to name the released order's file and the planned order files, as well as all the necessary information. The program then will display the loading policy menu as follows:

```
ENTER THE NUMBER OF WORKING-CENTERS ( =< 10 )? 5


     FOR WORK-CENTER  1
     -----------------

ENTER WORK-CENTER NAME ( < 20 CHRS )       ? TURN LATHE
ENTER NORMAL CAPACIYT (MAN-HOUR /DAY)? 8
ENTER MAX. CAPACITY (MAN-HOUR) /DAY) ? 16
ENTER EFFICIENCY FACTOR (%)            ? 90
ENTER UTILIZATION FACTOR (%)           ? 95
ENTER OPERATING OVER MAX. CAPACITY COST / HR.? 10
ENTER OPERATING BETWEEN MAX. AND NORMAL CAPACITY COST / HR.? 8
ENTER IDEL COST / HR.? 2

THIS WORK-CENTER HAS BEEN NUMBERED  1

HIT ANY KEY TO CONTINUE


     FOR WORK-CENTER  2
     -----------------

ENTER WORK-CENTER NAME ( < 20 CHRS )       ? MILL
ENTER NORMAL CAPACIYT (MAN-HOUR /DAY)? 8
ENTER MAX. CAPACITY (MAN-HOUR) /DAY) ? 16
ENTER EFFICIENCY FACTOR (%)            ? 80
ENTER UTILIZATION FACTOR (%)           ? 90
ENTER OPERATING OVER MAX. CAPACITY COST / HR.? 10
ENTER OPERATING BETWEEN MAX. AND NORMAL CAPACITY COST / HR.? 8
ENTER IDEL COST / HR.? 4

THIS WORK-CENTER HAS BEEN NUMBERED  2
```

PLEASE WAIT
FOR DISK OPERATION

WORK-CENTERS FILE

W.C. NO.	WORK-CENTER NAME	NOR. CAP.	MAX. CAP.	EFF. FACT.	UTIL. FACT.	OPERATIONAL COST / HR. IDLE	(> MAX)	BETWEEN MAX&NOR.
1	TURN LATHE	8	16	90	95	2	10	8
2	MILL	8	16	80	90	4	10	8
3	DRILL	8	16	90	105	2	12	4
4	HEAT TREAT	8	16	90	80	2	20	13
5	INSPECT	8	16	80	85	4	12	10

```
ENTER WORK-CENTER NO. TO CHANGE; 0 TO CONTINIUE? 0
```

Figure 16. Typical dialogue in building work center file.

```
LOADING / PLANNING POLICY :
---------------------------

     1- FORWARD LOADING
     2- BACKWARD LOADING
     3- ORDERS SPLITTING
     4- EXIT TO MAIN

ENTER CHOICE NO.?
```

The program starts loading the required capacity needed to produce each order to the specified work center along the planning horizon based on the user's selection for a loading policy. The logic and operation of each policy is explained in the next chapter. The program will display a reports menu which enables the user to view the results on the screen or make a printout on a line printer. The reports menu option is as follows:

```
LOADING POLICY  :FORWARD
-----------------
REPORTS OPTIONS :

     1- WORK-CENTERS LOAD PROFILE
     2- RELEASED ORDERS STATUS
     3- PLANNED OREDRS STATUS
     4- LOADING POLICY PREFORMANCE
     5- GRAPHING THE RESULT
     6- PRINTING THE RESULT
     7- EXIT TO MAIN MENU

ENTER CHOICE NO.?
```

Option #1 of the report's menu will display the work center load profile. A typical work center load profile report is as follows:

```
                              LOADING POLICY   :FORWARD
                              -----------------
                              WORK-CENTER NAME : INSPECT
                              -------------------
NORMAL CAPACITY (PER WEEK ) =  27.2     MAXIMUM CAPACITY (PER WEEK ) =  54.4
EFFECIENCY FACTOR           =  80 %     UTILIZATION FACTOR           =  85 %
OVER-MAX COST/HR.=  12     BTWN MAX & NOR. COST/HR.= 10     IDLE COST /HR. = 4
-------------------------------------------------------------------------------
WEEK      REQUIRED       LOAD    % UTILIZED    O = OVER LOADED   U = UNDER LOADED
 NO.      CAPACITY      STATUS                 N = NORMAL LOAD
-------------------------------------------------------------------------------
   1       8              U          28
   2       10             U          37
   3       15             U          55
   4       27             U          99
   5       37             N          136
   6       36             N          132
   7       0              U          0

HIT ANY KEY TO CONTINUE
```

The report contains the work center's data, required capacity in each time bucket, the percentage of utilization, which is found by dividing the required capacity by the work center's normal capacity, and finally, the loading status. The loading status is designated by an "N" for normal load, "U" for under load, or "O" for overload.

Option #2 will display the released orders status. This report contains the order dates, slack time and early or delay delivery costs. The slack time indicates an early finish if it is positive or delay if it is negative. The early/delay cost is calculated accordingly. A typical order status report is as follows:

LOADING POLICY:FORWARD

RELEASED ORDERS STATUS REPORT

ORDER NO.	DUE DATE	STARTING DATE	EARLIEST START	EARLIEST FINISH	SLACK # DAYS	DELAY/EARLY COST
100	29	1	1	10	19	1520
200	26	1	1	5	21	1260
300	23	4	4	17	6	600

HIT ANY KEY TO CONTINUE

Option #3 will display the planned order status in the same manner as the released orders report.

Option #4 will display loading policy performance report similar to the following:

LOADING POLICY :FORWARD

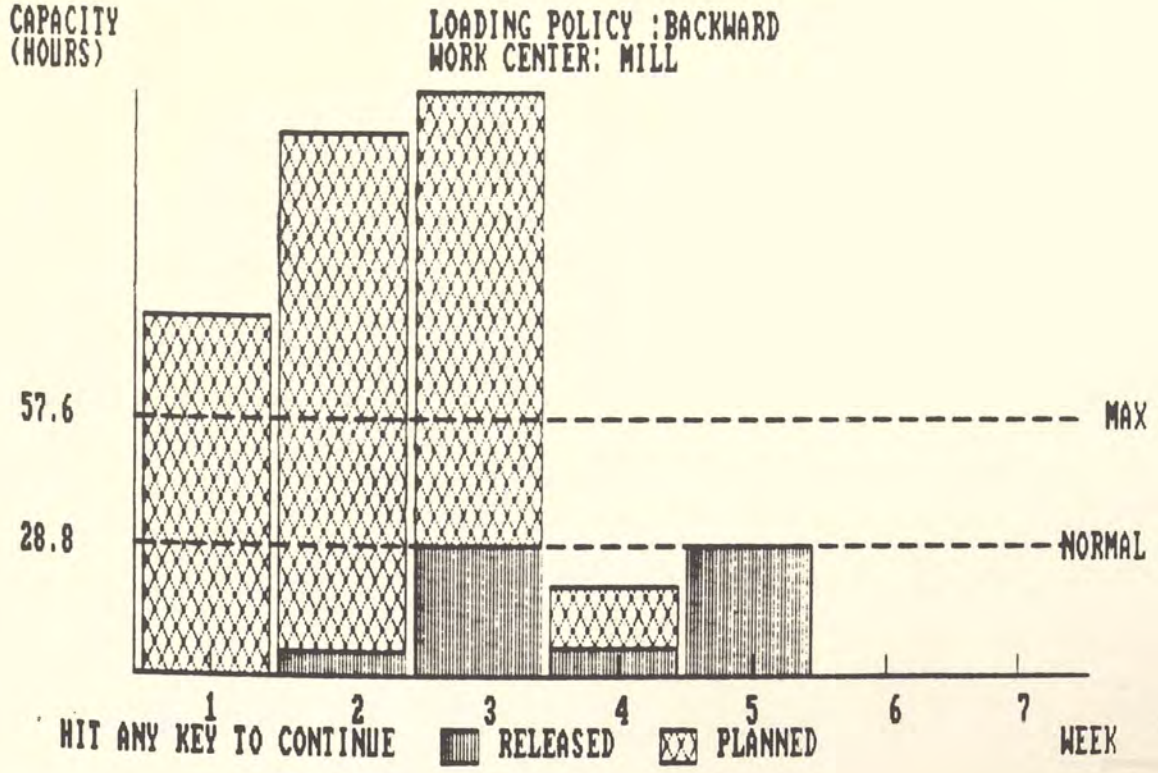
WORK-CENTER NAME	% BTWN MAX&NOR	% IDLE	% OVER-MAX	OPERATIONAL COST IDLE	OVER-MAX	BTWN. MAX&NOR	TOTAL
TURN LATHE	0	86	0	409	0	0	409
MILL	0	97	186	786	3749	0	4535
DRILL	0	91	0	481	0	0	481
HEAT TREAT	63	89	46	358	1850	1536	3744
INSPECT	38	69	0	524	0	730	1254
OVERALL AVERAGE	20	86	46	511	1119	453	2084

TOTAL OPERATIONAL COST	10423
TOTAL DELAY/EARLY DELIVERY COST	5433
LOADING POLICY GRAND TOTAL COST	15856

HIT ANY KEY TO CONTINUE

The report contains several measures of performance of the loading policy's effect for each work center. An overall measure of performance of the loading policy, indicating the total cost which would be incurred if the loading policy is implemented is presented. This figure may be used to compare the various scenarios that the user may generate and help him/her in selecting the best course of action.

Option #5 will employ the graphical component of the system to display the work center's load profile in a histogram using 15 time buckets a screen at a time. The required capacity histogram is shaded in two different shades to indicate the required capacity for planned and released orders in each time bucket. A typical report is as follows:



Option #6 will display a printing menu of options which allow the user to print a selective report or print all of the reports.

```
REPORTS OPTIONS :

      1- PRINT WORK-CENTERS LOAD PROFILE
      2- PRINT RELEASED ORDERS STATUS
      3- PRINT PLANNED OREDRS STATUS
      4- PRINT LOADING POLICY PREFORMANCE
      5- PRINT ALL REPORTS
      6- EXIT

ENTER CHOICE NO.?
```

The user may select option #7 to return to the loading policy menu from which he may elect a different loading policy as follows:

```
LOADING / PLANNING POLICY :
---------------------------

      1- FORWARD LOADING
      2- BACKWARD LOADING
      3- ORDERS SPLITTING
      4- EXIT TO MAIN

ENTER CHOICE NO.? 3
```

Option #3 of the loading policy menu will give the user a chance to split any orders that the user specifies before returning to the loading policy menu. The user could then investigate its affect on the capacity load profile when the backward or forward loading policy is used. It is worth noting that the use of this option may have an unpredictable effect on the load profile and the user is advised to be careful when using it. A typical case of order splitting process is as follows:

```
ENTER ORDER TYPE ( 1- RELEASED  2-PLANNED) ? 2
ENTER ORDER NO.                            ? 2


 (PARENT)  ORDER NO.  2  DATA
-----------------------------------
1-ORDER NO.                    : 2
2-PRODUCT NO.                  : 2
3-ORDER QUANTITY               : 400
4-DELIVERY LEAD TIME           : 20
5-STARTING PERIOD              : 2
6-UNIT EARLY FINISH COST/DAY   : .04
7-UNIT DELAY COST / DAY        : .4

 PART #1  ORDER NO.  2  DATA              PART #2  OF ORDER NO. 2  DATA
-----------------------------------      -----------------------------------
1-ORDER NO.                    : 2       1-ORDER NO.                    : 6
2-PRODUCT NO.                  : 2       2-PRODUCT NO.                  : 2
3-ORDER QUANTITY               : 200     3-ORDER QUANTITY               : 200
4-DELIVERY LEAD TIME           : 10      4-DELIVERY LEAD TIME           : 10
5-STARTING PERIOD              : 2       5-STARTING PERIOD              : 10
6-UNIT EARLY FINISH COST/DAY   : .04     6-UNIT EARLY FINISH COST/DAY   : .04
7-UNIT DELAY COST / DAY        : .4      7-UNIT DELAY COST / DAY        : .4
 ENTER OPTION NO. TO CHANGE ; 0 TO CONTINUE?
```

Order number 2 of the planned file is being split into two parts. Part 1 will be stored in the file with the original order file number, but the order quantity is reduced according to the user specifications (200 units) and due date is changed to 10 working days. Part 2 is assigned a different order number (6), and the starting date is changed to 10.

Option #4 of the loading policy will exit from the "capacity" program and return to the main menu. Before exiting the "capacity" program, a check will be made to see if the order splitting has been executed. If so, the system will give the user a chance to save the new orders file (release and/or plan) to a different file or save it under its original name. This is handled as follows:

```
WOULD LIKE TO SAVE THE MODIFIED PLANNED
ORDERS FILE ON DIFFERENT FILE (Y/N)      ? Y

ENTER PLANNED ORDERS FILE NAME   ? PLAN1
ENTER THE DISK DRIVE ( A,B,OR C )? A
```

System Limitations

The current system has the following limitations:

1. It handles only up to 10 work centers and 10 products, although increasing the size can be done by changing the dimension statements in the program.

2. The system does not maintain calendar and all dates are handled as number of working days.

3. No automatic capacity leveling component is provided. Instead, system advises the user on the results of various policies.

4. The system is limited to capacity planning, not scheduling. However, it may be used for scheduling if process time components (queue time, setup time, etc.) are introduced in the process along with additional routines.

5. Currently, the system does not shift the work load to the alternative work centers if the first choice work center is overloaded. It maintains an alternative work center in the product file for the user to use if he so desires.

6. The system does not have priority rules in loading the orders to the work centers. It uses the first in, first out (FIFO) rules.

Hardware and Software Requirements

Currently, the system is written in BASIC programming language and runs on the IBM microcomputers. The following are the minimum hardware and software requirements for best use of the system.

1. IBM microcomputer family (PC, XT, AT) or compatibles with 64K of minimum memory.

2. DOS 2.1 or higher operating system with BASICA.

3. Color monitor with graphics capability unless the user is not interested in the graphical presentation.

4. IBM compatible printer.

CHAPTER VI

SYSTEM LOGIC

Capacity planning requirements technique (infinite capacity) is used in the system to calculate the capacity requirements over the planning horizon. The system gives the user the chance of using a day, weekly, or monthly planning period (time bucket). The order file's names are requested to be input for creating the orders files and before each run, in order to facilitate the uses of different orders files. This is a useful feature in the sense that the user can create different order files for different plans and investigate their capacity plan independently. Other information related to the product(s), work center(s), and production facilities are retrieved from the shop data base (content of these data is explained in Chapter V).

Forward or backward loading policies are used by the system in generating the required capacity. Other scenarios may be generated by using the order splitting option with any of the two policies. The order splitting is an interesting option. It can be used effectively to smooth out the capacity and make sure that the order's due dates are met. Also, it may be used for answering questions of the "what if" type. It may require that the user be aware of various actions when he/she can measure its effect. The

steps of the working algorithm with its loading policies are explained schematically by the flow chart in Figure 17.

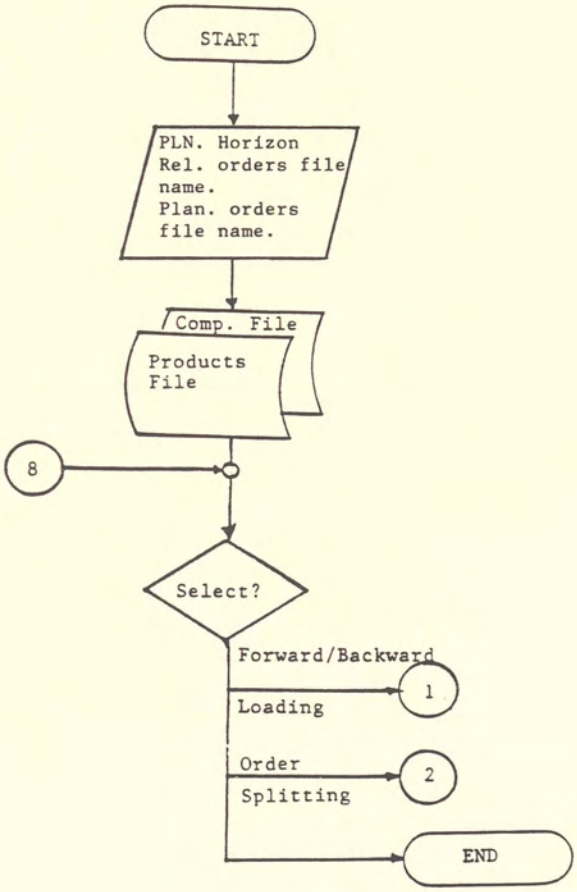


Figure 17. Flow chart of loading policies program (capacity).

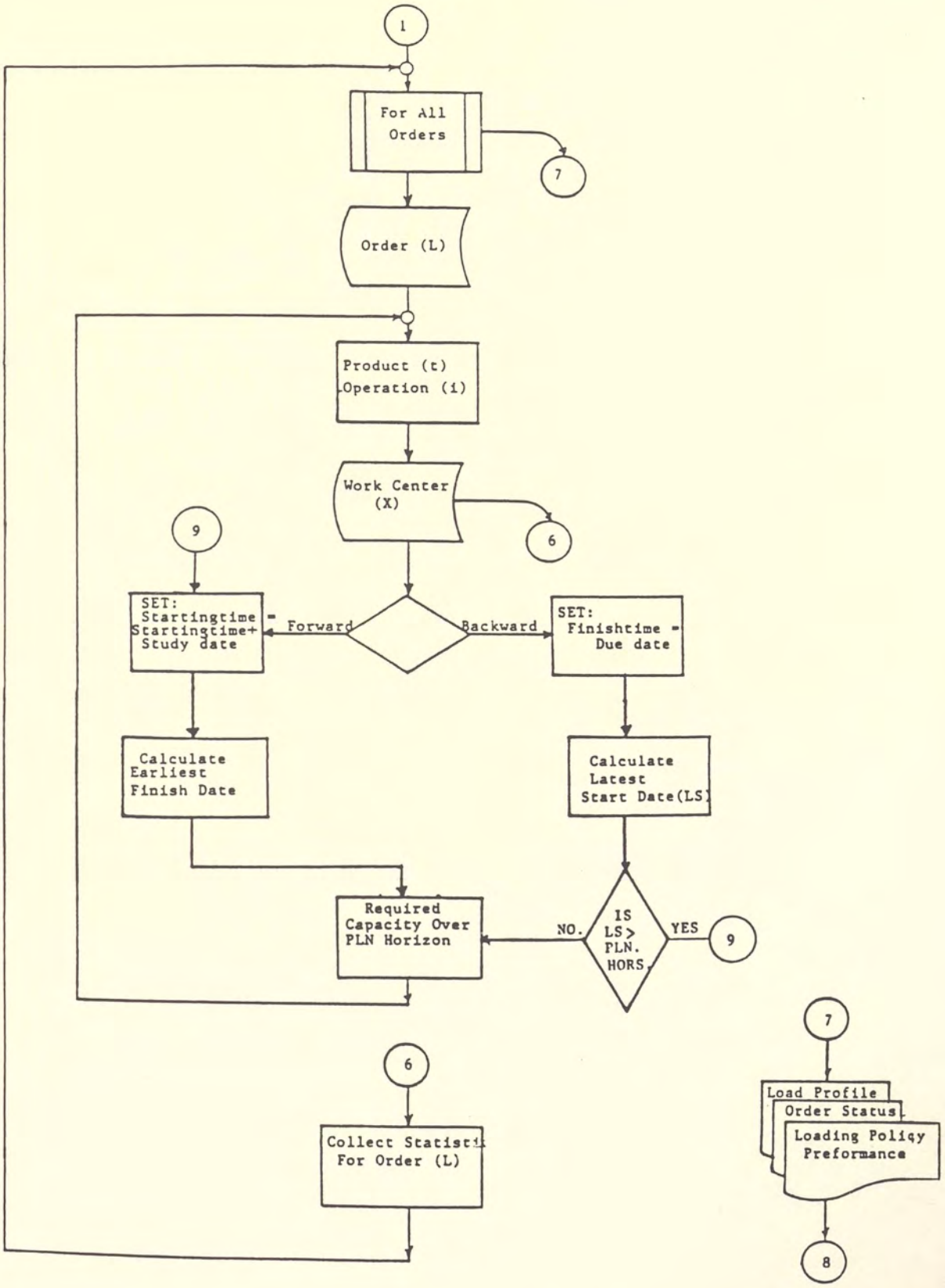


Figure 17 -- CONTINUED

Once the user inputs the order's file name (planned, released), the planning horizon, study start date, and time bucket, the program loads the company information and product's file. The loading policies menu of options is displayed and a choice can be made, such as forward or backward loading policy. Order splitting may also be chosen with any of the two loading policies. After the user chooses a loading policy, the orders files are accessed. The system starts loading the orders and calculates their early finish date (forward), late start (backward), and required capacity for each operation in the specified work centers. Released orders are loaded first, in the chronological order in which they are stored (FIFO). After the released orders are processed, the planned orders are then loaded in their chronological order and processed.

For each order, the system uses the product file to access information about the sequence of operations that the product needs to go through, process time, and the process work center. In the case of forward loading, the system sets the starting date of first operation to starting date of the order. The required capacity and the manufacturing lead time for each operation is then calculated and added to a bucket accumulator. Each operation will start from the time its precedent operation ended. The finish date of the last operation sets the earliest finish of the order.

In the case of backward loading, the finish date of the last operation is set to order due date and start of the last operation is calculated by finding its manufacturing lead time and subtracting it from the finish date. The finish date of the preceding operation is set to the start date of the last operation. This process is repeated until the start of the first operation is found which sets the early start of the order, the forward and backward loading process was shown previously in Figure 6. If the calculated earliest start date of the order exceeds the start date of the order, then order is loaded using the forward policy. Hence, the order will encounter a delay. The required capacities for each work center at each time bucket are used to accumulate the capacity for each planning period.

Once all the orders are processed, the system will start calculating statistics such as orders early start dates, finish, and delay of early costs for each order, etc. After the system finishes collecting the statistics, the reports menu option will be displayed. The contents of each report were shown in the previous chapter.

CHAPTER VII

CASE APPLICATION

Assume the case of a machine shop that consists of five work centers and produces three different types of products. Each of these products require different sets of operations, the details of which are shown in Figure 18. The shop has a set of released and planned orders that are shown in Table 7. Furthermore, the machine shop operates five days a week, with a daily operation of eight hours. Currently, the machine shop operates on a single shift, but two shifts can be operated whenever needed. The work center's data are shown in Table 8. Management wants to simulate the future required capacity for each work center using a weekly time bucket that is necessary to produce these orders.

Work center / Products	Turn Lathe	Mill	Drill	Heat Treat	Inspect
PRD#1	.01 (1) →	.15 (2) →	.02 (3) →	.04 (4) →	.05 (5)
PRD#2		.2 (1) →		.15 (2) →	.05 (3)
PRD#3	.05 (1) →		.1 (2) →		.05 (3)

Figure 18. Products operations sequence.

TABLE 7

ORDERS DATA

NO.	PRODUCT NO.	QUANTITY	DELIVERY LEAD TIME	STARTING DATE	FINISH UNIT EARLY	COST/DAY DELAY
Released Orders:						
100	1	200	28	0	.03	.4
200	3	150	25	0	.03	.4
300	2	200	22	0	.04	.5
Planned Orders:						
1	1	500	18	0	.05	.3
2	2	400	20	2	.04	.4
3	3	300	20	5	.03	.5
4	1	500	25	0	.04	.5
5	2	400	20	0	.03	.4

TABLE 8

WORK CENTERS DATA

WORK CENTER NAME	NORMAL CAPACITY	MAXIMUM CAPACITY	EFFICIENCY FACTOR	UTILIZATION FACTOR	OPERATIONAL COST/HOURS		
					IDLE	OVER MAXIMUM	BETWEEN MAXIMUM AND NORMAL HOURS
Turn Lathe	8	16	90	95	2	10	8
Mill	8	16	80	90	4	10	8
Drill	8	16	90	105	2	12	4
Heat Trent	8	16	90	80	2	20	12
Inspect	8	10	80	85	4	12	10

After creating the data base of the company, the load profile may be generated. A system output for the given case study is as follows: A sample step-by-step run of applying the capacity planning system for forward and backward loading policies and the various reports which may be generated are included in Appendix B.

System Output Employing Forward Loading

```
                              LOADING POLICY   :FORWARD
                              ------------------
                              WORK-CENTER NAME : TURN LATHE
                              --------------------
NORMAL CAPACITY (PER WEEK ) =  34.19   MAXIMUM CAPACITY (PER WEEK ) =  68.39
EFFECIENCY FACTOR           =  90 %    UTILIZATION FACTOR           =  95 %
OVER-MAX COST/HR.=  10    BTWN MAX & NOR. COST/HR.= 8     IDLE COST /HR. = 2
-------------------------------------------------------------------------------
WEEK      REQUIRED       LOAD   % UTILIZED   O = OVER LOADED   U = UNDER LOADED
 NO.      CAPACITY      STATUS                N = NORMAL LOAD
-------------------------------------------------------------------------------
   1       20             U          57
   2       15             U          44
   3       0              U          0
   4       0              U          0
   5       0              U          0
   6       0              U          0
   7       0              U          0

HIT ANY KEY TO CONTINUE
```

```
                              LOADING POLICY   :FORWARD
                              ------------------
                              WORK-CENTER NAME : MILL
                              --------------------
NORMAL CAPACITY (PER WEEK ) =  28.8    MAXIMUM CAPACITY (PER WEEK ) =  57.6
EFFECIENCY FACTOR           =  80 %    UTILIZATION FACTOR           =  90 %
OVER-MAX COST/HR.=  10    BTWN MAX & NOR. COST/HR.= 8     IDLE COST /HR. = 4
-------------------------------------------------------------------------------
WEEK      REQUIRED       LOAD   % UTILIZED   O = OVER LOADED   U = UNDER LOADED
 NO.      CAPACITY      STATUS                N = NORMAL LOAD
-------------------------------------------------------------------------------
   1       152            O          529
   2       129            O          446
   3       94             O          326
   4       5              U          18
   5       0              U          0
   6       0              U          0
   7       0              U          0

HIT ANY KEY TO CONTINUE
```

LOADING POLICY :FORWARD

WORK-CENTER NAME : DRILL

NORMAL CAPACITY (PER WEEK) = 37.79 MAXIMUM CAPACITY (PER WEEK) = 75.59
EFFECIENCY FACTOR = 90 % UTILIZATION FACTOR = 105 %
OVER-MAX COST/HR.= 12 BTWN MAX & NOR. COST/HR.= 4 IDLE COST /HR. = 2

WEEK NO.	REQUIRED CAPACITY	LOAD STATUS	% UTILIZED	O = OVER LOADED N = NORMAL LOAD	U = UNDER LOADED
1	0	U	0		
2	4	U	11		
3	19	U	49		
4	1	U	4		
5	0	U	0		
6	0	U	0		
7	0	U	0		

HIT ANY KEY TO CONTINUE

LOADING POLICY :FORWARD

WORK-CENTER NAME : HEAT TREAT

NORMAL CAPACITY (PER WEEK) = 28.8 MAXIMUM CAPACITY (PER WEEK) = 57.6
EFFECIENCY FACTOR = 90 % UTILIZATION FACTOR = 80 %
OVER-MAX COST/HR.= 20 BTWN MAX & NOR. COST/HR.= 12 IDLE COST /HR. = 2

WEEK NO.	REQUIRED CAPACITY	LOAD STATUS	% UTILIZED	O = OVER LOADED N = NORMAL LOAD	U = UNDER LOADED
1	15	U	52		
2	43	N	148		
3	32	N	110		
4	92	O	321		
5	54	N	186		
6	8	U	26		
7	0	U	0		

HIT ANY KEY TO CONTINUE

LOADING POLICY :FORWARD

WORK-CENTER NAME : INSPECT

NORMAL CAPACITY (PER WEEK) = 27.2 MAXIMUM CAPACITY (PER WEEK) = 54.4
EFFECIENCY FACTOR = 80 % UTILIZATION FACTOR = 85 %
OVER-MAX COST/HR.= 12 BTWN MAX & NOR. COST/HR.= 10 IDLE COST /HR. = 4

WEEK NO.	REQUIRED CAPACITY	LOAD STATUS	% UTILIZED	O = OVER LOADED N = NORMAL LOAD	U = UNDER LOADED
1	8	U	28		
2	10	U	37		
3	25	U	92		
4	17	U	62		
5	37	N	136		
6	36	N	132		
7	0	U	0		

HIT ANY KEY TO CONTINUE

LOADING POLICY:FORWARD

RELEASED ORDERS STATUS REPORT

ORDER NO.	DUE DATE	STARTING DATE	EARLIEST START	EARLIEST FINISH	SLACK # DAYS	DELAY/EARLY COST
100	29	1	1	10	19	1520
200	26	1	1	5	21	1260
300	23	1	1	14	9	900

HIT ANY KEY TO CONTINUE

LOADING POLICY:FORWARD

PLANNED ORDERS STATUS REPORT

ORDER NO.	DUE DATE	STARTING DATE	EARLIEST START	EARLIEST FINISH	SLACK # DAYS	DELAY/EARLY COST
1	19	1	1	24	-5	125
2	21	3	3	30	-9	144
3	21	6	6	15	6	900
4	26	1	1	24	2	500
5	21	1	1	28	-7	84

HIT ANY KEY TO CONTINUE

LOADING POLICY :FORWARD

WORK-CENTER NAME	% BTWN MAX&NOR	% IDLE	% OVER-MAX	OPERATIONAL COST IDLE	OVER-MAX	BTWN. MAX&NOR	TOTAL
TURN LATHE	0	86	0	409	0	0	409
MILL	0	97	186	786	3749	0	4535
DRILL	0	91	0	481	0	0	481
HEAT TREAT	63	89	46	358	1850	1536	3744
INSPECT	38	69	0	524	0	730	1254
OVERALL AVERAGE	20	86	46	511	1119	453	2084

TOTAL OPERATIONAL COST	10423
TOTAL DELAY/EARLY DELIVERY COST	5433
LOADING POLICY GRAND TOTAL COST	15856

HIT ANY KEY TO CONTINUE

System Output Employing Backward Loading

```
                                LOADING POLICY   :BACKWARD
                                ------------------
                                WORK-CENTER NAME : TURN LATHE
                                --------------------
NORMAL CAPACITY (PER WEEK ) =  34.19   MAXIMUM CAPACITY (PER WEEK ) =  68.39
EFFECIENCY FACTOR           =  90 %    UTILIZATION FACTOR           =  95 %
OVER-MAX COST/HR.=  10    BTWN MAX & NOR. COST/HR.= 8     IDLE COST /HR. = 2
-------------------------------------------------------------------------------
WEEK      REQUIRED       LOAD   % UTILIZED   O = OVER LOADED   U = UNDER LOADED
 NO.      CAPACITY      STATUS               N = NORMAL LOAD
-------------------------------------------------------------------------------
   1       10             U          29
   2       0              U          0
   3       15             U          44
   4       2              U          6
   5       8              U          22
   6       0              U          0
   7       0              U          0

HIT ANY KEY TO CONTINUE


                                LOADING POLICY   :BACKWARD
                                ------------------
                                WORK-CENTER NAME : MILL
                                --------------------
NORMAL CAPACITY (PER WEEK ) =  28.8    MAXIMUM CAPACITY (PER WEEK ) =  57.6
EFFECIENCY FACTOR           =  80 %    UTILIZATION FACTOR           =  90 %
OVER-MAX COST/HR.=  10    BTWN MAX & NOR. COST/HR.= 8     IDLE COST /HR. = 4
-------------------------------------------------------------------------------
WEEK      REQUIRED       LOAD   % UTILIZED   O = OVER LOADED   U = UNDER LOADED
 NO.      CAPACITY      STATUS               N = NORMAL LOAD
-------------------------------------------------------------------------------
   1       80             O          277
   2       121            O          420
   3       130            O          452
   4       20             U          71
   5       29             N          100
   6       0              U          0
   7       0              U          0

HIT ANY KEY TO CONTINUE


                                LOADING POLICY   :BACKWARD
                                ------------------
                                WORK-CENTER NAME : DRILL
                                --------------------
NORMAL CAPACITY (PER WEEK ) =  37.79   MAXIMUM CAPACITY (PER WEEK ) =  75.59
EFFECIENCY FACTOR           =  90 %    UTILIZATION FACTOR           =  105 %
OVER-MAX COST/HR.=  12    BTWN MAX & NOR. COST/HR.= 4     IDLE COST /HR. = 2
-------------------------------------------------------------------------------
WEEK      REQUIRED       LOAD   % UTILIZED   O = OVER LOADED   U = UNDER LOADED
 NO.      CAPACITY      STATUS               N = NORMAL LOAD
-------------------------------------------------------------------------------
   1       0              U          0
   2       0              U          0
   3       9              U          25
   4       11             U          28
   5       0              U          0
   6       4              U          11
   7       0              U          0

HIT ANY KEY TO CONTINUE
```

LOADING POLICY :BACKWARD

WORK-CENTER NAME : HEAT TREAT

NORMAL CAPACITY (PER WEEK) = 28.8 MAXIMUM CAPACITY (PER WEEK) = 57.6
EFFECIENCY FACTOR = 90 % UTILIZATION FACTOR = 80 %
OVER-MAX COST/HR.= 20 BTWN MAX & NOR. COST/HR.= 12 IDLE COST /HR. = 2

WEEK NO.	REQUIRED CAPACITY	LOAD STATUS	% UTILIZED
1	0	U	0
2	0	U	0
3	18	U	62
4	126	O	439
5	83	O	289
6	16	U	54
7	0	U	0

O = OVER LOADED U = UNDER LOADED
N = NORMAL LOAD

HIT ANY KEY TO CONTINUE

LOADING POLICY :BACKWARD

WORK-CENTER NAME : INSPECT

NORMAL CAPACITY (PER WEEK) = 27.2 MAXIMUM CAPACITY (PER WEEK) = 54.4
EFFECIENCY FACTOR = 80 % UTILIZATION FACTOR = 85 %
OVER-MAX COST/HR.= 12 BTWN MAX & NOR. COST/HR.= 10 IDLE COST /HR. = 4

WEEK NO.	REQUIRED CAPACITY	LOAD STATUS	% UTILIZED
1	0	U	0
2	0	U	0
3	0	U	0
4	18	U	66
5	58	O	212
6	57	O	209
7	0	U	0

O = OVER LOADED U = UNDER LOADED
N = NORMAL LOAD

HIT ANY KEY TO CONTINUE

LOADING POLICY :BACKWARD

RELEASED ORDERS STATUS REPORT

ORDER NO.	DUE DATE	STARTING DATE	LATEST START	LATEST FINISH	SLACK # DAYS	(DELAY/EARLY) COST
100	29	1	20	29	19	0
200	26	1	21	26	20	0
300	23	1	10	23	9	0

HIT ANY KEY TO CONTINUE

LOADING POLICY :BACKWARD

PLANNED ORDERS STATUS REPORT

ORDER NO.	DUE DATE	STARTING DATE	LATEST START	LATEST FINISH	SLACK # DAYS	(DELAY/EARLY) COST
1	19	1	1	24	-5	125
2	21	3	3	30	-9	144
3	21	6	11	21	5	0
4	26	1	3	26	2	0
5	21	1	1	28	-7	84

HIT ANY KEY TO CONTINUE

LOADING POLICY :BACKWARD

WORK-CENTER NAME	% BTWN MAX&NOR	% IDLE	% OVER-MAX	OPERATIONAL COST IDLE	OVER-MAX	BTWN. MAX&NOR	TOTAL
TURN LATHE	0	86	0	409	0	0	409
MILL	14	90	164	725	3309	230	4264
DRILL	0	91	0	481	0	0	481
HEAT TREAT	0	83	104	337	4194	0	4531
INSPECT	0	91	60	689	1374	0	2063
OVERALL AVERAGE	2	88	65	528	1775	46	2349

TOTAL OPERATIONAL COST	11748
TOTAL DELAY/EARLY DELIVERY COST	353
LOADING POLICY GRAND TOTAL COST	12101

HIT ANY KEY TO CONTINUE

Based on the sample run, it seems that the backward loading policy may be superior to apply. Superiority is based only on the comparison between the costs of $15,856 for forward and $12,101 for backward.

While the technique is considered a simulation of various scenarios, the user may try other scenarios based on his/her circumstances which may product better results.

CHAPTER VIII

CONCLUSIONS

Capacity planning is an important part in the integrated manufacturing systems. There are indications that one of the least developed areas of the manufacturing production and control systems in industry deals with the capacity planning. One reason for this fact might be the amount of computation involved in applying various loading techniques. This is especially true for some of the most sophisticated capacity planning techniques such as the CRP technique since their operations require extensive data collection and computerized files of various kinds (Wemmerlov 1984).

It is impossible to identify a single specific technique with a specific level of planning and control for all companies. The decision on which capacity planning is to be used is very dependent on the company itself and its desire to have detailed information, planning in long or short range term, and how much it is willing to pay for maintaining the system.

Several software packages are available, mostly designed to be a part of the full production and control system (PCS). Hence, if a company does not have the full PCS, it will have problems implementing the capacity planning by itself. Also, most of these

packages are mainframe dependent and highly sophisticated. Recently, a limited number of microcomputer packages were developed; however, it cannot be labeled as independent capacity planning packages (Chong 1984).

With the widespread use of microcomputers and the increase of their availability and power, it became necessary to develop a second generation of capacity planning packages. These packages should be simpler, more practical than some of the elegant, highly sophisticated packages which are available in the market, and best of all, microcomputer based. This will make them indispensable tools for the small-to-medium working shop or company that lacks expertise or the funds in acquiring the highly sophisticated packages.

The capacity planning package presented in this report is one such package. It is adequate for job shops and companies that do not have the funds or expertise to attain and maintain a large integrated production control system.

The package is designed to encompass the following:

1. The package will generate a number of scenarios which satisfies the production plan subject to the constraint of work center capacities and product(s) operational sequence. The user is consulted in the selection of the scenarios.

2. A user-friendly, menu driven, and self-documented package.

3. Forecast the future required capacity over the planning horizon, using the capacity requirement planning technique (infinite planning).

4. Employ a forward or backward loading policy with order splitting option.

5. A daily, weekly, or monthly time bucket.

6. Produce a graphical load profile, showing the expected capacity loaded hours in each work center in user specified time increment (time bucket) over the planning horizon.

7. Estimates orders, delivery dates and cost associated with any delay and/or early finish of these orders.

8. Produce a report on the production capacity load for each work center in user specified time increment (time bucket).

9. An overall cost, based on the loading policy, may be produced that can be used to compare various scenarios and may guide the user in his/her decision making.

This package is a good base to further studies in the capacity planning problems.

Some of the possible areas of study are: developing a good measure of performance factors that can be used to compare the various loading policies and developing a heuristic module to level out the capacity along the planning horizon.

CHAPTER IX

FUTURE RESEARCH

Despite the effort done in the development of this capacity planning system, a great deal of work remains to be done, especially enhancing its capabilities as a decision support system. The developed system in this research is a tool that can be used in addressing some specific areas of research identified during the study.

1. The capacity system as it stands now does not have enough intelligence to suggest any remedies to the problem it may encounter (i.e., overload, underload). It simply identifies the imbalance between the available and required capacity to the analyst at various stages of the planning horizon. Then, the analyst decides on the courses of actions. An overall cost figure is produced by the system to measure the performance of the loading policy. It would certainly be of large value if the system could provide a number of alternatives through which the problems could either be eliminated or reduced. The initial ideas in this direction suggest using some of the recent techniques of Expert Systems. This may entail identifying parameters or indicators to the various problems associated with the capacity planning and best remedies to them. The thrust of the research

would concentrate on the identification of the indicators and collection of information on the realistic solution in such cases. A mechanism of storing and updating this information based on the outcomes of the remedies may support the suggested decisions by the system in the future. The research may contribute to enhancing the system capabilities by making it self-teaching; thus, storing information on past problems and their corrective actions and use them in solving similar future problems.

2. Another area of research is to include proven analytical approaches among the possible loading scenarios. The problem of scheduling "N" jobs on "M" machines (Taha 1982) is similar to the cases associated with the capacity planning algorithm. However, they may serve different purposes. Problems usually associated with the analytical techniques include the difficulty of modeling the problem by the analyst to match the algorithms' assumptions. Another problem is that in many cases these algorithms in their search for optimal solution would label the problem as infeasible. It may be possible through the use of the idea of goal programming (Lee 1974) to devise a methodology to bridge the gap between purely optimal techniques (such as the use of integer programming of scheduling "N" jobs on "M" machines), and the practical aspects of implementing solutions. This also may be done by making the algorithm transparent to the user. Thus, unsophisticated users can benefit from the technique.

3. As has been mentioned in Chapter III, the system is currently capable of handling medium- to long-range capacity planning. However, the system can be enhanced by including short-range capacity planning capability. This will require more information about the work centers, priority rules, and a mechanism to keep track of all jobs in all work centers during each planning period. This will allow the planner to use the capacity planning system as a scheduling system.

APPENDIX

SYSTEM LISTING

```
100 REM *** PROG. NAME MAIN ***
110 KEY OFF :OPTION BASE 1
120 ON ERROR GOTO 1830
130 GOSUB 190 :REM LOGO
140 GOSUB 320 :REM MAIN MENU
150 CLS :KEY ON :END
160 REM
170 REM
180 CLS:FOR I = 1 TO 10:PRINT:NEXT I :RETURN
190 GOSUB 180
200  C$=CHR$(&H81)+CHR$(&H42)+CHR$(&H24)+CHR$(&H18)+CHR$(&H18)+CHR$(&H24)+CHR$(&
H42)+CHR$(&H81)
210 SCREEN 2
220 LINE (170,60)-(445,128),1,B
230 LINE (20,20)-(610,170),1,B
240 LOCATE 10,27:PRINT "CAPACITY PLANNING SYSTEM "
250 LOCATE 12,29:PRINT " DR. YASSER HOSNI"
260 LOCATE 13,29:PRINT "  ALI ALSEBAIEE"
270 LOCATE 15,25:PRINT "UNIVERSITY OF CENTRAL FLORIDA "
280 PAINT (100,40),C$,1
290 FOR I = 1 TO 300 :NEXT I
300 SCREEN 0
310 RETURN
320 CLS
330 FOR I =1 TO 7 :PRINT:NEXT I
340 PRINT TAB(20); "MAIN MENU OF OPTIONS :" :PRINT
350 'PRINT TAB(25);"1- INSTRUCTIONS "
360 PRINT TAB(25);"1- CURRENT SYSTEM STATUS"
370 PRINT TAB(25);"2- COMPANY DATA BASE (CREATE/UPDATE)"
380 PRINT TAB(25);"3- ORDERS DATA BASE (CREATE/UPDATE)"
390 PRINT TAB(25);"4- CAPACITY PLANNING PROFILE(S)"
400 PRINT TAB(25);"5- EXIT SYSTEM "
410 PRINT:PRINT TAB(20);"ENTER CHOICE NO.";:INPUT CN%
420 IF CN% < 1 OR CN% > 5 THEN 430 ELSE 440
430 PRINT:PRINT "CHOICE NO. MUST BE 1,2,3,4,5 OR 6 ":GOTO 410
440 IF CN% = 5 THEN RETURN
450 ON CN% GOTO 530,460,470,490,500
460 RUN "COMPFIL"
470 RUN "ORDERFIL"
480 RUN "WORINPRF"
490 RUN "CAPACITY"
500 RETURN
510 PRINT "NOT READY "
520 PAINT (150,40),C$,1
530 REM *** SYSTEM CURRENT INFORMATIN ***
540 REM
550 GOTO 610
560 PRINT:PRINT:PRINT "ENTER ANY KEY TO CONTINUE "
570 Y$ =INKEY$ :IF Y$ ="" THEN 570
580 RETURN
590 REM
600 CLS:FOR I = 1 TO 9:PRINT:NEXT I :RETURN
610 REM *** COMPANY FILE ***
620 GOSUB 1780 :REM WAITING MASSAGE
630 OPEN "I",2,"COMPF"
640     INPUT #2,CN$,NP,NWC,WWY,WHD,WDW,WDM
650 CLOSE 2
660 CLS:PRINT
670 PRINT TAB(15);"COPMANY FILE HAS THE FOLLOWING INFORMATION : ":PRINT
680 PRINT TAB(20);" COPMANY NAME : "; CN$
690 PRINT TAB(20);" NO. OF PRODUCTS                    : ";NP
700 PRINT TAB(20);" NO. OF WORKING CENTERS             : "; NWC
710 PRINT TAB(20);" NO. OF WORKING WEEKS IN A YEAR     : "; WWY
```

```
720 PRINT TAB(20);" NO. OF WORKING HOURS IN A DAY     : "; WHD
730 PRINT TAB(20);" NO. OF WORKING DAYS IN A WEEK     : "; WDW
740 PRINT TAB(20);" NO. OF WORKING DAYS IN A MONTH    : "; WDM
750 GOSUB 560
760 REM *** WORK-CENTERS DATA ***
770 GOSUB 1780
780 OPEN "R",1,"WORKCF",76
790 FIELD 1,15 AS WCN$,5 AS NC$, 5 AS MC$,5 AS EF$,5 AS UF$, 12 AS OC$, 12 AS BC
$, 12 AS IC$
800 NWC =0
810 CLS:PRINT:PRINT
820 PRINT TAB(35);"WORK-CENTERS FILE"
830 PRINT TAB(35);"------------------":PRINT
840 PRINT "W.C.";TAB(6);"WORK-CENTER";TAB(22);"NOR.";TAB(28);"MAX.";TAB(34);"EFF
.";TAB(41);"UTIL.";TAB(48);"   OPERATIONAL COST / HR."
850 PRINT "NO.";TAB(6);"NAME";TAB(22);"CAP.";TAB(28);"CAP.";TAB(34);"FACT.";TAB(
41);"FACT.";TAB(48);"IDLE";TAB(54);"( > MAX )";TAB(65);"BTWN MAX & NOR."
860 FOR I=1 TO 75 :PRINT "-";:NEXT I
870 NWC = NWC + 1
880 GET 1,NWC
890 IF WCN$ = STRING$(15,0) THEN 930
900 NC = CVS(NC$) : MC = CVS(MC$): EF= CVS(EF$):UF=CVS(UF$):OC= CVS(OC$):BC= CVS
(BC$):IC= CVS(IC$)
910 PRINT TAB(1);NWC;TAB(6);WCN$;TAB(22);NC;TAB(28);MC;TAB(34);EF;TAB(41);UF;TAB
(48);IC;TAB(55);OC;TAB(66);BC
920 GOTO 870
930 CLOSE 1
940 GOSUB 560
950 REM *** PRODUCTS DATA ***"
960 REM DIM PN$(20),PS(20,10),OT(20,10),PS1(20,10),OT1(20,10),PS2(20,10),OT2(20,
10) :REM PRODUCTS DIM
970 GOSUB 1780
980 OPEN "I",1,"PRODUCTF"
990 INPUT #1,NP
1000 FOR L = 1 TO NP
1010 INPUT #1,PN$(L)
1020     FOR I = 1 TO 10
1030         INPUT #1,PS(L,I),OT(L,I),PS1(L,I),OT1(L,I),PS2(L,I),OT2(L,I)
1040    NEXT I
1050 NEXT L
1060 CLOSE 1
1070 FOR L =1 TO NP
1080 CLS:PRINT
1090 PRINT TAB(30);"PRODUCTS FILE"
1100 PRINT TAB(30);"--------------":PRINT
1110 REM
1120 PRINT TAB(10);"PRODUCT NO. : ";L;TAB(30);"PRODUCT NAME : ";PN$(L)
1130 FOR I=1 TO 75 :PRINT "-";:NEXT I
1140 PRINT TAB(5);"SEQUENCE";TAB(39);"1ST ALT.";TAB(59);"2ND ALT."
1150 PRINT TAB(5);"OF WORK-CENTERS";TAB(25)"PROCESS";TAB(37);"WORK";TAB(44);"PRO
CESS";TAB(57);"WORK";TAB(64);"PROCESS"
1160 PRINT TAB(5);"(OPERATIONS)";TAB(26);"TIME";TAB(35);"CENTER #";TAB(45)"TIME"
;TAB(55);"CENTER #";TAB(65);"TIME"
1170 FOR I=1 TO 75 :PRINT "-";:NEXT I
1180 FOR I = 1 TO 10
1190 IF PS(L,I) = 0 THEN 1210
1200     PRINT TAB(7);PS(L,I);TAB(26);OT(L,I);TAB(36);PS1(L,I);TAB(46);OT1(L,I);
         TAB(55);PS2(L,I);TAB(65);OT2(L,I)
1210 NEXT I
1220 GOSUB 560
1230 NEXT L
1240 CLOSE 1
1250 REM *** ORDERS FILES ***
1260 GOSUB 180
1270 PRINT TAB(25);"ENTER RELEASED ORDERS FILE NAME  ";:INPUT F$
1280 PRINT TAB(25);"ENTER PLANNED ORDERS FILE NAME   ";:INPUT F1$
```

```
1290 PRINT TAB(25);"ENTER THE DISK DRIVE ( A,B,OR C )";:INPUT D$
1300 IF D$="A" OR D$ ="a" OR D$ ="B" OR D$ ="b" OR D$ ="C" OR D$ ="c" THEN 1310
ELSE 1290
1310 A$ = D$+":"+F$
1320 A1$ = D$+":"+F1$
1330 REM *** ORDER DATA ***
1340 REM GOSUB 110:GOSUB 3740
1350 FLAG = 0
1360 GOSUB 180
1370 V$ = "RELEASED":GOSUB 1400
1380 V$ = "PLANNED":A$=A1$ :GOSUB 1400
1390 GOTO 320
1400 OPEN "I",1,A$
1410 REM OPEN "O",2,"A$.TMP"
1420 INPUT #1,NW
1430 REM WRITE #2,NW
1440 WHILE EOF (1) = 0
1450      INPUT #1,N,PT,OQ,DD,SD,C1,C2
1460      GOSUB 180 :GOSUB 1610
1470 REM WRITE #2,N,OT,PT,OQ,DD,SD,OP
1480 WEND
1490 CLOSE 1
1500 REM IF FLAG = 0 THEN 1715 ELSE 1750
1510 REM CLS:GOSUB 110
1520 REM PRINT TAB(20);"ORDER NO. ";ND;" IS NOT IN THE ORDERS FILE"
1530 REM KILL "A$.TMP":GOSUB 90
1540 REM RETURN
1550 REM GOSUB 2050
1560 REM KILL A$
1570 REM NAME "A$.TMP" AS A$
1580 REM B 110
1590 REM PRINT TAB(20);"ORDER NO. ";ND;" IS SAVED AFTER THE CHANGES "
1600 RETURN
1610 REM *** DISPLAYING ORDER DATA ***
1620 CLS:PRINT:PRINT
1630 PRINT TAB(25);V$;" ORDERS FILE"
1640 PRINT TAB(25);"------------------":PRINT
1650 PRINT TAB(20);" ORDER NO.";N;" HAS THE FOLLOWING DATA"
1660 PRINT TAB(20);"----------------------------------------":PRINT
1670 PRINT TAB(20);"ORDER NO.                              : ";N
1680 'PRINT TAB(20);" 2- ORDER TYPE      = ";OT
1690 PRINT TAB(20);"PRODUCT TYPE                           : ";PT
1700 PRINT TAB(20);"ORDER QUANTITY                         : ";OQ
1710 PRINT TAB(20);"DELIVERY LEAD TIME                     : ";DD
1720 PRINT TAB(20);"STARTING PERIOD (FROM STUDY DATE):     : ";SD
1730 'PRINT TAB(20);"ORDER PRIORITY = ";OP
1740 PRINT TAB(20);"EARLY FINISH COST (PER DAY)            : ";C1
1750 PRINT TAB(20);"DELAY COST (PER DAY)                   : ";C2
1760 GOSUB 560
1770 RETURN
1780 GOSUB 180:PRINT TAB(30);:COLOR 16,7,0
1790 PRINT "     PLEASE WAIT     ":COLOR 7,0,0
1800 PRINT TAB(30);:COLOR 0,7,0:PRINT " FOR DISK OPERATION "
1810 COLOR 7,0,0
1820 RETURN
1830 REM *** ERROR MASEGES ***
1840 REM
1850 IF ERR = 53 THEN BEEP:GOSUB 180 :PRINT TAB(20);"FILE NOT FOUND; PLEASE CHEC
K THE FILE NAME":GOSUB 560 :RESUME 320
1860 IF ERR = 70 THEN BEEP:GOSUB 180 :PRINT TAB(20);"DISK  WRITE PROTECTED;PLEAS
E REMOVE IT":GOSUB 560 :RESUME 320
1870 IF ERR = 61 THEN BEEP:GOSUB 180 :PRINT TAB(20);"DISK  FULL ":GOSUB 560 :RES
UME 320
1880 IF ERR = 27 THEN BEEP:GOSUB 180 :PRINT TAB(20);"OUT OF PAPER":GOSUB 560 :RE
SUME 320
1890 IF ERR = 55 THEN BEEP:GOSUB 180 :PRINT TAB(20);"FILE ALREADY EXISTS;PLEASE
CHOOSE ANOTHER NAME":GOSUB 560 :RESUME 320
1900 BEEP:ON ERROR GOTO 0
```

```
100 REM *** PROGRAM NAME : ORDERFIL ***
110 KEY OFF : OPTION BASE 1
120 ON ERROR GOTO 1900
130 GOSUB 200 :REM MAIN MENU
140 CHAIN "MAIN",30,ALL
150 PRINT:PRINT:PRINT "ENTER ANY KEY TO CONTINUE "
160 Y$ = INKEY$ :IF Y$ ="" THEN 160
170 RETURN
180 REM
190 CLS:FOR I = 1 TO 10 :PRINT:NEXT I:RETURN
200 GOSUB 190
210 PRINT TAB(20);"ORDERS DATA BASE :"
220 PRINT TAB(20);"------------------":PRINT
230 PRINT TAB(25);"1- RELEASED ORDERS FILE"
240 PRINT TAB(25);"2- PLANNED ORDERS FILE "
250 PRINT TAB(25);"3- EXIT TO MAIN MENU"
260 PRINT:PRINT TAB(20);"ENTER CHOICE NO. ";:INPUT CN%
270 IF CN% < 1 OR CN% > 3 THEN 280 ELSE 290
280 PRINT :PRINT:PRINT " CHOICE NO. MUST BE EITHER 1,2,OR 3":GOSUB 150 :GOTO 200

290 IF CN% = 3 THEN RETURN
300 IF CN% = 1 THEN V$ = "RELEASED" ELSE V$ = "PLANNED"
310 NF= 0:GOSUB 400
320 GOTO 200
330 REM
340 GOSUB 190 :GOSUB 350 :GOTO 400
350 PRINT TAB(25);"ENTER THE FILE NAME";:INPUT F$
360 PRINT TAB(25);"ENTER THE DISK DRIVE ( A,B,OR C )";:INPUT D$
370 IF D$="A" OR D$ ="a" OR D$ ="B" OR D$ ="b" OR D$ ="C" OR D$ ="c" THEN 380 EL
SE 360
380 A$ = D$+":"+F$
390 RETURN
400 GOSUB 190
410 PRINT TAB(20);V$;" ORDERS FILE :"
420 PRINT TAB(20);"-------------------- ":PRINT
430 PRINT TAB(25);"1- CREATE NEW FILE"
440 PRINT TAB(25);"2- ADD NEW ORDER(S)"
450 PRINT TAB(25);"3- DELETE ORDER(S)"
460 PRINT TAB(25);"4- UPDATE ORDER DATA"
470 PRINT TAB(25);"5- EXIT "
480 PRINT:PRINT TAB(20);"ENTER CHOICE NO. ";:INPUT CN1%
490 IF CN1% < 1 OR CN1% > 5 THEN 500 ELSE 510
500 PRINT :PRINT:PRINT " CHOICE NO. MUST BE EITHER 1,2,3,4 OR 5":GOSUB 150 :GOTO
 400
510 IF CN1% = 5 THEN RETURN
520 IF NF = 0 THEN NF = 1 :GOSUB 190:GOSUB 350
530 ON CN1%  GOSUB 550,650,1110,1360
540 GOTO 400
550 REM *** CREATING NEW ORDERS FILE ***
560 GOSUB 190 :GOSUB 350
570 GOSUB 1840
580 OPEN "O",1,A$
590 GOSUB 190
600 PRINT TAB(20);"ENTER THE NO. OF ORDERS";:INPUT NW
610 WRITE #1,NW
620 GOSUB 710
630 GOSUB 1400
640 RETURN
650 REM *** ADDING NEW ORDERS ***
660 GOSUB 670:GOTO 960
670 GOSUB 1840:OPEN "A",1,A$
680 GOSUB 190
690  PRINT TAB(20);"ENTER NO. OF THE NEW ORDERS";:INPUT NW
```

```
700 REM CLS:GOSUB 110
710 FOR L = 1 TO NW
720  GOSUB 190
730 PRINT TAB(15);"FOR ORDER ";L
740 PRINT TAB(15);"----------"  :PRINT
750 PRINT TAB(10);"ENTER ORDER NO.";:INPUT N
760 GOSUB 770 :GOTO 910
770 PRINT TAB(10);"ENTER PRODUCT NO. ";:INPUT PT
780 IF PT <= 0 THEN 770
790 PRINT TAB(10);"ENTER ORDER QUANTITY";:INPUT OQ
800 IF OQ <= 0 THEN 790
810 PRINT TAB(10);"ENTER DELIVERY LEAD TIME ( # OF WORKING DAYS )";:INPUT DD
820 IF DD <= 0 THEN 810
830 PRINT TAB(10);"ENTER STARTING DATE (# OF WORKING DAYS FROM STUDY DATE)";:INP
UT SD
840 IF SD > DD THEN PRINT "STARTING DATE CAN'T BE GREATER THAN THE DELIVERY DATE
; PLEASE REENTER":GOTO 830
850 IF SD < 0 THEN 830
860 PRINT TAB(10);"ENTER UNIT EARLY FINISH COST (PER DAY)";:INPUT C1
870  IF C1 < 0 THEN 860
880 PRINT TAB(10);"ENTER UNIT DELAY COST (PER DAY)";:INPUT C2
890  IF C2 < 0 THEN 880
900 RETURN
910 WRITE #1,N,PT,OQ,DD,SD,C1,C2
920 NEXT L
930 GOSUB 1840
940 CLOSE 1
950 RETURN
960 REM
970 OPEN "I",1,A$
980 INPUT #1,NW1
990 OPEN "O",2,"A$.TMP"
1000 NW = NW + NW1
1010 WRITE #2,NW
1020 WHILE  EOF (1) = 0
1030      INPUT #1,N,PT,OQ,DD,SD,C1,C2
1040      WRITE #2,N,PT,OQ,DD,SD,C1,C2
1050 WEND
1060 CLOSE 1,2
1070 KILL A$
1080 NAME "A$.TMP" AS A$
1090 K = 0 : Z = 0 :GOSUB 1400
1100 RETURN
1110 REM *** DELETING ORDER ***
1120 C = 0
1130 GOSUB 1840
1140 OPEN "I",1,A$
1150 OPEN "O",2,"A$.TMP"
1160 INPUT #1,NW
1170 WRITE #2,NW
1180 WHILE EOF(1) = 0
1190   INPUT #1,N,PT,OQ,DD,SD,C1,C2
1200 GOSUB 1600 :GOSUB 1280
1210 WEND
1220 GOSUB 1840
1230 CLOSE 1,2
1240 KILL A$
1250 NAME "A$.TMP" AS A$
1260 IF C > 0 THEN NW = - C :GOSUB 970
1270 RETURN
1280 PRINT:PRINT
1290 PRINT TAB(20);"WOULD YOU LIKE TO DELETE THIS ORDER ( Y/N )";:INPUT Y$
1300 IF Y$ = "Y" OR Y$ ="y" THEN 1310 ELSE 1320
1310 PRINT TAB(20);"ARE YOU SURE YOU WANT TO DELETE THIS ORDER ( Y/N )";:INPUT Y
$
1320 IF Y$ = "Y" OR Y$= "y" OR Y$ = "N" OR Y$ = "n" THEN 1330 ELSE 1290
```

```
1330 IF Y$ = "Y" OR Y$ ="y" THEN C = C + 1 :RETURN
1340 WRITE #2,N,PT,OQ,DD,SD,C1,C2
1350 RETURN
1360 REM *** UPDATING ORDER DATA ***
1370 FLAG = 0
1380 CLS:GOSUB 190
1390 GOSUB 1840
1400 OPEN "I",1,A$
1410 OPEN "O",2,"A$.TMP"
1420 INPUT #1,NW
1430 WRITE #2,NW
1440 WHILE EOF (1) = 0
1450      INPUT #1,N,PT,OQ,DD,SD,C1,C2
1460 IF CN1% = 2 THEN 1470 ELSE 1490
1470 K = K + 1
1480 IF (K > NW1) AND Z = 0 THEN GOTO 1490 ELSE 1500
1490      GOSUB 190 :GOSUB 1580
1500      WRITE #2,N,PT,OQ,DD,SD,C1,C2
1510 IF K = NW THEN Z = 1 : K  =0
1520 WEND
1530 GOSUB 1840
1540 CLOSE 1,2
1550 KILL A$
1560 NAME "A$.TMP" AS A$
1570 RETURN
1580 REM *** DISPLAYING ORDER DATA ***
1590 GOSUB 1600  :GOTO 1730
1600 CLS:PRINT:PRINT
1610  PRINT TAB(30);V$;" ORDERS FILE "
1620  PRINT TAB(30);"------------------- ":PRINT
1630 PRINT TAB(20);" ORDER NO.";N;" HAS THE FOLLOWING DATA"
1640 PRINT TAB(20);"----------------------------------------":PRINT
1650 PRINT TAB(20);" 1- ORDER NO.                              : ";N
1660 PRINT TAB(20);" 2- PRODUCT NO.                            : ";PT
1670 PRINT TAB(20);" 3- ORDER QUANTITY                         : ";OQ
1680 PRINT TAB(20);" 4- DELIVERY LEAD TIME                     : ";DD
1690 PRINT TAB(20);" 5- STARTING PERIOD (FROM STUDY DATE): ";SD
1700 PRINT TAB(20);" 6- ITEM EARLY FINISH COST (PER DAY) : ";C1
1710 PRINT TAB(20);" 7- ITEM DELAY COST (PER DAY)        : ";C2
1720 RETURN
1730 PRINT:PRINT TAB(15);"ENTER OPTION NO. TO CHANGE; 0 TO CONTINUE ";:INPUT CN2
%
1740 IF CN2% < 0  OR CN2% >7 THEN 1600
1750 IF CN2% = 0 THEN RETURN
1760 PRINT:PRINT TAB(15);"ENTER THE NEW VALUE ";:INPUT NV
1770 IF CN2% = 1 THEN N = NV :GOTO 1580
1780 IF CN2% = 2 THEN PT = NV :GOTO 1580
1790 IF CN2% = 3 THEN OQ = NV :GOTO 1580
1800 IF CN2% = 4 THEN DD = NV :GOTO 1580
1810 IF CN2% = 5 THEN SD = NV :GOTO 1580
1820 IF CN2% = 6 THEN C1 = NV :GOTO 1580
1830 IF CN2% = 7 THEN C2 = NV :GOTO 1580
1840 GOSUB 190:PRINT TAB(25);:COLOR 16,7,0
1850 PRINT "     PLEASE WAIT     " :COLOR 7,0,0
1860 PRINT TAB(25);:COLOR 0,7,0
1870 PRINT TAB(25);" FOR DISK OPERATION "
1880 COLOR 7,0,0
1890 RETURN
1900 REM *** ERROR MASEGES ***
1910 REM
1920 IF ERR = 53 THEN BEEP:GOSUB 190 :PRINT TAB(20);"FILE NOT FOUND; PLEASE CHEC
K THE FILENAME":GOSUB 150 :RESUME 400
1930 IF ERR = 70 THEN BEEP:GOSUB 190 :PRINT TAB(20);"DISK  WRITE PROTECTED;PLEAS
E REMOVE IT":GOSUB 150 :RESUME 400
1940 IF ERR = 61 THEN BEEP:GOSUB 190 :PRINT TAB(20);"DISK  FULL ":GOSUB 150 :RES
UME 400
1950 IF ERR = 27 THEN BEEP:GOSUB 190 :PRINT TAB(20);"OUT OF PAPER":GOSUB 150 :RE
SUME 400
1960 IF ERR = 55 THEN BEEP:GOSUB 190 :PRINT TAB(20);"FILE ALREADY EXISTS;PLEASE
CHOOSE ANOTHER NAME":GOSUB 150 :RESUME 400
1970 BEEP:ON ERROR GOTO 0
```

```
100 REM **** PROGRAM TO GENERATE THE COMPANY FILE ****
110 KEY OFF :OPTION BASE 1
120 DIM W$(20),C(20,7) :REM WORK-CENTER  DIM
130 DIM PN$(20),PS(20,10),OT(20,10),PS1(20,10),OT1(20,10),PS2(20,10),OT2(20,10)
:REM PRODUCTS DIM
140 GOSUB 220 :REM MAIN MENU
150 CHAIN "MAIN",200,ALL
160 REM
170 PRINT:PRINT:COLOR 14,0,0:PRINT "HIT ANY KEY TO CONTINUE " :COLOR 7,0,0
180 Y$ =INKEY$ :IF Y$ ="" THEN 180
190 RETURN
200 REM
210 CLS:FOR I = 1 TO 6:PRINT:NEXT I :RETURN
220 GOSUB 210
230 PRINT TAB(20);"COMPANY DATA BASE :"
240 PRINT TAB(20);"--------------------":PRINT
250 PRINT TAB(25);"1- CREATE NEW COMPANY FILE"
260 PRINT TAB(25);"2- UPDATE THE COMPANY FILE"
270 PRINT TAB(25);"3- CREATE/UPDATE WORK-CENTERS FILE"
280 PRINT TAB(25);"4- CREATE/UPDATE THE PRODUCTS FILE"
290 PRINT TAB(25);"5- EXIT TO MAIN PROGRAM "
300 PRINT :PRINT TAB(20);"ENTER CHOICE NO.";:INPUT CN2%
310 IF  CN2% < 1 OR CN2% > 5 THEN 320 ELSE 330
320 PRINT:PRINT:PRINT "CHOICE NO. MUST BE EITHER 1,2,3,4,OR 5":GOSUB 170 :GOTO
220
330 IF CN2% = 5 THEN RETURN
340 ON CN2% GOSUB  360,560,1010,2640
350 GOTO 220
360  REM *** CREATING NEW COMPANY FILE ***
370 OPEN "O",1,"COMPF"
380 GOSUB 210
390 PRINT TAB(20);"ENTER COPMANY NAME";:INPUT CN$
400 PRINT TAB(20);"ENTER THE NUMBER OF PRODUCTS ( =< 10 )";:INPUT NP
410 IF NP =< 0 OR NP >10 THEN 400
420 PRINT TAB(20);"ENTER THE NUMBER OF WORKING CENTERS ( =< 10 )";:INPUT NWC
430 IF NWC =< 0 OR NWC >10 THEN 420
440 PRINT TAB(20);"ENTER THE NO. OF WORKING WEEKS IN A YEAR";:INPUT WWY
450 IF WWY =< 0 OR WWY >52 THEN 440
460 PRINT TAB(20);"ENTER THE NO. OF WORKING DAYS IN A WEEK ";:INPUT WDW
470 IF WDW =< 0 OR WDW >7 THEN 460
480 PRINT TAB(20);"ENTER THE NO. OF WORKING DAYS IN A MONTH";:INPUT WDM
490 IF WDW =< 0 OR WDW >31 THEN 480
500 PRINT TAB(20);"ENTER THE NO. OF WOKING HOURS IN A DAY ";:INPUT WHD
510 IF WHD =< 0 OR WHD >24 THEN 500
520 WRITE #1,CN$,NP,NWC,WWY,WHD,WDW,WDM
530 GOSUB 4220:CLOSE 1
540 GOSUB 560
550 RETURN
560 REM *** UPDATING COMPANY FILE ***
570 GOSUB 580 :GOTO 630
580 GOSUB 4220 :REM WAITING MASSAGE
590 OPEN "I",2,"COMPF"
600     INPUT #2,CN$,NP,NWC,WWY,WHD,WDW,WDM
610 CLOSE 2
620 RETURN
630 GOSUB 210
640 PRINT TAB(15);"COPMANY FILE HAS THE FOLLOWING INFORMATION : ":PRINT
650 PRINT TAB(20);"1- COPMANY NAME : "; CN$
660 PRINT TAB(20);"2- NO. OF PRODUCTS ( =< 10 )          : ";NP
670 PRINT TAB(20);"3- NO. OF WORKING CENTERS ( =< 10 ) : "; NWC
680 PRINT TAB(20);"4- NO. OF WORKING WEEKS IN A YEAR    : "; WWY
690 PRINT TAB(20);"5- NO. OF WORKING HOURS IN A DAY     : "; WHD
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```
700 PRINT TAB(20);"6- NO. OF WORKING DAYS IN A WEEK    : "; WDW
710 PRINT TAB(20);"7- NO. OF WORKING DAYS IN A MONTH   : "; WDM
720 PRINT:PRINT TAB(15);"ENTER OPTION NO. TO CHANGE, 0 TO CONTINUE ";:INPUT CN%
730 IF CN% < 0 OR CN% > 7 THEN 560
740 IF CN% = 0 THEN 880
750 PRINT:PRINT TAB(15);"ENTER THE NEW VALUE ";:IF CN% = 1 THEN INPUT NV$
                                                ELSE INPUT NV
760 IF (CN% =2 AND NV =< 0) OR (CN% =2 AND NV >10) THEN 750
770 IF (CN% =3 AND NV =< 0) OR (CN% = 3 AND NV >20) THEN 750
780 IF (CN% =4 AND NV =< 0) OR (CN% = 4 AND NV >52) THEN 750
790 IF (CN% = 5 AND NV =< 0) OR (CN% = 5 AND NV >24) THEN 750
800 IF (CN% =6 AND NV =< 0) OR (CN% = 6 AND NV > 7 ) THEN 750
810 IF (CN% =7 AND NV =< 0) OR (CN% = 7 AND NV > 31) THEN 750
820 IF CN% =1 THEN CN$ = NV$ :GOTO 630
830 IF CN% =2 THEN NP = NV :XX= 1:GOTO 630
840 IF CN% =3 THEN NWC = NV:YY= 1:GOTO 630
850 IF CN% =4 THEN WWY = NV:GOTO 630
860 IF CN% =5 THEN WHD = NV:GOTO 630
870 IF CN% =6 THEN WDW = NV:GOTO 630
880 IF CN% =7 THEN WDM = NV:GOTO 630
890 GOSUB 4220
900 OPEN "O",2,"COMPF"
910   WRITE #2,CN$,NP,NWC,WWY,WHD,WDW,WDM
920 CLOSE 2
930 IF XX =1 OR YY = 1 THEN 940 ELSE 1000
940 GOSUB 210:BEEP
950 PRINT:PRINT TAB(20);:COLOR 16,7,0
960 PRINT "                    WARNING                              ":COLOR 7,0,0
970 IF XX=1 AND YY =1 THEN PRINT TAB(20);:COLOR 0,7,0:PRINT " YOU MUST UPDATE PR
ODUCTS AND WORK CENTERS FILES ":COLOR 7,0,0 :GOTO 990
980 PRINT TAB(20);:COLOR 0,7,0:PRINT " YOU MUST UPDATE THE ";:IF XX=1 THEN PRINT
 "PRODUCTS FILE                ";  ELSE PRINT "WORK CENTERS";" FILE            ":CO
LOR 7,0,0
990 GOSUB 160
1000 RETURN
1010 REM *** UPDATING WORK-CENTERS FILE ***
1020 GOSUB 210
1030 PRINT TAB(20);" WORK-CENTER FILE :"
1040 PRINT TAB(20);" ------------------":PRINT
1050 PRINT TAB(25);"1- CREATE NEW FILE"
1060 PRINT TAB(25);"2- ADD NEW WORK-CENTER(S) "
1070 PRINT TAB(25);"3- UPDATE WORK-CENTER(S) DATA "
1080 PRINT TAB(25);"4- DELETE WORK-CENTER(S) "
1090 PRINT TAB(25);"5- EXIT    "
1100 PRINT :PRINT TAB(20);"ENTER CHOICE NO.";:INPUT CN1%
1110 IF  CN1% < 1 OR CN1% > 5 THEN 1120 ELSE 1130
1120 PRINT:PRINT:PRINT "CHOICE NO. MUST BE EITHER 1,2,3,4,OR 5 ":GOSUB 170 :GOTO
  1020
1130 IF CN1% = 5 THEN RETURN
1140 ON CN1% GOSUB  1160,1570,1860,2130
1150 GOTO 1020
1160  REM *** CREATING NEW WORK-CENTERS FILE***
1170 GOSUB 4220
1180 X = 1 :'KILL "WORKCF"
1190 OPEN "R",1,"WORKCF",76
1200 FIELD 1,15 AS WCN$,5 AS NC$, 5 AS MC$, 5 AS EF$, 5 AS UF$, 12 AS OC$,12 AS
BC$, 12 AS IC$
1210 GOSUB 210
1220 PRINT TAB(20);"ENTER THE NUMBER OF WORKING-CENTERS ( =< 10 )";:INPUT NWC
1230 IF NWC =< 0 OR NWC >10 THEN 1220
1240 GOSUB 210
1250 FOR L = X TO NWC
1260 GOSUB 210
1270 PRINT TAB(10);"FOR WORK-CENTER ";L -X +1
1280 PRINT TAB(10);"------------------ ":PRINT
1290 GOSUB 1300 :GOTO 1470
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1300 PRINT TAB(5);"ENTER WORK-CENTER NAME ( < 20 CHRS )      ";:INPUT WCNT$
1310 PRINT TAB(5);"ENTER NORMAL CAPACIYT (MAN-HOUR /DAY)";:INPUT NCT
1320 PRINT TAB(5);"ENTER MAX. CAPACITY (MAN-HOUR) /DAY) ";:INPUT MCT
1330 IF MCT < NCT THEN PRINT TAB(5);" MAX. CAPACITY HAS TO EXCEED THE NORMAL; PL
EASE REENTER";:GOTO 1320
1340 PRINT TAB(5);"ENTER EFFICIENCY FACTOR (%)          ";:INPUT EFT
1350 IF EFT < 1  THEN PRINT TAB(5);" ENTER EFFICIENCY FACTOR WITHOUT DECIMAL; P'
EASE REENTER";:GOTO 1340
1360 PRINT TAB(5);"ENTER UTILIZATION FACTOR (%)          ";:INPUT UFT
1370 IF UFT < 1  THEN PRINT TAB(5);" ENTER UTILIZATION FACTOR WITHOUT DECIMAL; P
LEASE REENTER";:GOTO 1360
1380 IF  UF > 100 THEN PRINT TAB(5);" UTILIZATION FACTOR CAN'T BE > 100; PLEASE
REENTER";:GOTO 1360
1390 PRINT TAB(5);"ENTER OPERATING OVER MAX. CAPACITY COST / HR.";:INPUT OCC
1400 PRINT TAB(5);"ENTER OPERATING BETWEEN MAX. AND NORMAL CAPACITY COST / HR.";
:INPUT BCC
1410 PRINT TAB(5);"ENTER IDEL COST / HR.";:INPUT ICC
1420 LSET WCN$ = WCNT$
1430 LSET NC$ = MKS$(NCT) :LSET MC$ = MKS$(MCT)
1440 LSET EF$ = MKS$(EFT) :LSET UF$ = MKS$(UFT)
1450 LSET OC$ = MKS$(OCC) :LSET BC$ = MKS$(BCC):LSET IC$= MKS$(ICC)
1460 RETURN
1470 PRINT:PRINT TAB(5);"THIS WORK-CENTER HAS BEEN NUMBERED ";L :GOSUB 170
1480 PUT  1,L
1490 REM RETURN
1500 PRINT
1510 NEXT L
1520 CLOSE 1
1530 IF CN1% = 2 THEN RETURN
1540 T= 0 :GOSUB 4220:GOSUB 1760:REM UPDATING THE COMPANY FILE
1550 GOSUB 1880
1560 RETURN
1570 REM *** ADDING NEW WORK-CENTER ***
1580 GOSUB 210
1590 PRINT TAB(20);"HOW MANY NEW WORK-CENTERS ";:INPUT T
1600 IF T =< 0 OR T >10 THEN 1590
1610 GOSUB 4220 :GOSUB 210
1620 OPEN "R",1,"WORKCF",76
1630 FIELD 1,15 AS WCN$,5 AS NC$, 5 AS MC$, 5 AS EF$, 5 AS UF$, 12 AS OC$,12 AS
BC$, 12 AS IC$
1640 REM FINDING LENGHT OF FILE
1650   GET 1
1660 IF WCN$ <> STRING$(15,0) THEN 1640
1670 REM INPUT DATA OF NEW WORK-CENTERS
1680  X = LOC(1) : NWC = LOC(1) + T - 1
1690 IF NWC > 10 THEN 1700 ELSE 1740
1700  GOSUB 210 :PRINT TAB(20);"THE TOTAL NO. OF WORK-CENTER CAN'T EXCEED 10 ":P
RINT TAB(20);"THE COMPANY HAS ALLREADY ";X-1;" WORK-CENTERS;PLEASE REENTER" :PRI
NT
1710 PRINT TAB(20);"HOW MANY NEW WORK-CENTERS ";:INPUT T
1720 NWC = X + T -1
1730 IF NWC =< 0 OR NWC >10 THEN 1700
1740  GOSUB 1250
1750 GOSUB 4220:CLOSE 1
1760 REM UPDATING THE COMPANY FILE
1770 OPEN "I",2,"COMPF"
1780 OPEN "O",3,"COMPF.TMP"
1790    INPUT #2,CN$,NP,NWC,WWY,WHD,WDW,WDM
1800    NWC = NWC + T
1810    WRITE #3,CN$,NP,NWC,WWY,WHD,WDW,WDM
1820 CLOSE 2,3
1830 KILL "COMPF"
1840 NAME "COMPF.TMP" AS "COMPF"
1850 RETURN
1860 REM *** UPDATING WORK-CENTERS ***"
1870 GOSUB 4220
```

```
1880 OPEN "R",1,"WORKCF",76
1890 FIELD 1,15 AS WCN$,5 AS NC$, 5 AS MC$, 5 AS EF$, 5 AS UF$, 12 AS OC$,12 AS
BC$, 12 AS IC$
1900 NWC =0
1910 CLS:PRINT:PRINT
1920 PRINT TAB(35);"WORK-CENTERS FILE"
1930 PRINT TAB(35);"------------------":PRINT
1940 PRINT "W.C.";TAB(6);"WORK-CENTER";TAB(22);"NOR.";TAB(28);"MAX.";TAB(34);"EF
F.";TAB(41);"UTIL.";TAB(48);"   OPERATIONAL COST / HR."
1950 PRINT "NO.";TAB(6);"NAME";TAB(22);"CAP.";TAB(28);"CAP.";TAB(34);"FACT.";TAB
(41);"FACT.";TAB(48);"IDLE";TAB(54);"( > MAX )";TAB(64);"BETWEEN MAX&NOR."
1960 FOR I=1 TO 78 :PRINT "-";:NEXT I
1970 NWC = NWC + 1
1980 GET 1,NWC
1990 IF WCN$ = STRING$(15,0) THEN 2030
2000 NC = CVS(NC$) : MC = CVS(MC$): EF= CVS(EF$):UF=CVS(UF$):OC= CVS(OC$):BC= CV
S(BC$):IC= CVS(IC$)
2010 PRINT TAB(1);NWC;TAB(6);WCN$;TAB(22);NC;TAB(28);MC;TAB(34);EF;TAB(41);UF;TA
B(48);IC;TAB(55);OC;TAB(66);BC
2020 GOTO 1970
2030 PRINT:PRINT TAB(5);"ENTER WORK-CENTER NO. TO CHANGE; 0 TO CONTINIUE";:INPUT
 OP2
2040 IF OP2 < 0 OR OP2 > NWC THEN PRINT TAB(5);"WORK-CENTER MUST BE BETWEEN 1&";
NWC;" PLEASE REENTER ":GOTO 2030
2050 IF OP2 = 0 THEN 2110
2060 GOSUB 210
2070 PRINT TAB(10);"FOR WORK-CENTER NO.";OP2
2080 PRINT TAB(10);"--------------------- ":PRINT
2090 GOSUB 1300
2100 PUT 1,OP2  :GOTO 1900
2110 GOSUB 4220:CLOSE 1
2120 RETURN
2130 REM *** DELETING A WORK-CENTER ****
2140 OPEN "R",1,"WORKCF",76
2150 FIELD 1,15 AS WCN$,5 AS NC$, 5 AS MC$, 5 AS EF$, 5 AS UF$, 12 AS OC$,12 AS
BC$, 12 AS IC$
2160 NWC =0 :OP2 = 0
2170 NWC = NWC + 1
2180 GET 1,NWC
2190 IF WCN$ = STRING$(15,0) THEN 2220
2200 C(NWC,1) = CVS(NC$) : C(NWC,2) = CVS(MC$) :C(NWC,3)= CVS(EF$):C(NWC,4)=CVS(
UF$):C(NWC,5)=CVS(OC$):C(NWC,6)=CVS(BC$):C(NWC,7)=CVS(IC$):W$(NWC)= WCN$
2210 GOTO 2170
2220 T = NWC -1 :CLOSE 1
2230 CLS:PRINT:PRINT
2240 PRINT TAB(35);"WORK-CENTERS FILE"
2250 PRINT TAB(35);"------------------":PRINT
2260 PRINT "W.C.";TAB(6);"WORK-CENTER";TAB(22);"NOR.";TAB(28);"MAX.";TAB(34);"EF
F.";TAB(41);"UTIL.";TAB(48);"   OPERATIONAL COST / HR."
2270 PRINT "NO.";TAB(6);"NAME";TAB(22);"CAP.";TAB(28);"CAP.";TAB(34);"FACT.";TAB
(41);"FACT.";TAB(48);"IDLE";TAB(54);"( > MAX )";TAB(65);"BETWEEN MAX&NOR."
2280 FOR I=1 TO 75 :PRINT "-";:NEXT I
2290 FOR I = 1 TO T
2300 IF OP2 = 0 THEN 2340
2310 IF I >= OP2 THEN 2320 ELSE 2340
2320 W$(I) = W$(I+1)
2330 C(I,1) = C(I+1,1) : C(I,2) = C(I+1,2):C(I,3)=C(I+1,3) :C(I,4)=C(I+1,4):C(I,
5)=C(I+1,5):C(I,6)=C(I+1,6):C(I,7)=C(I+1,7)
2340 PRINT TAB(1);I;TAB(6);W$(I);TAB(22);C(I,1);TAB(28);C(I,2);TAB(34);C(I,3);TA
B(41);C(I,4);TAB(48);C(I,5);TAB(55);C(I,6);TAB(66);C(I,7)
2350 NEXT I
2360 PRINT:PRINT TAB(5);"ENTER WORK-CENTER NO. TO DELETE; 0 TO CONTINIUE";:INPUT
 OP2
2370 IF OP2 < 0 OR OP2 > T THEN PRINT TAB(5);"WORK-CENTER MUST BE BETWEEN 1&";T;
" PLEASE REENTER ":GOTO 2360
2380 IF OP2 = 0 THEN  2420 ELSE  2390
```

```
2390 PRINT TAB(5);"ARE SURE YOU WANT TO DELETE WORK CENTER # ";OP2;" (Y/N)";:INP
UT Y$
2400 IF Y$ ="Y" OR Y$="y" OR Y$="N" OR Y$="n" THEN 2410 ELSE 2390
2410 IF Y$ ="Y" OR Y$="y" THEN T =T-1 :GOTO 2230 ELSE OP2 = T+1:GOTO 2230
2420 GOSUB 4220 :REM WAITNG MASSAGE
2430 OPEN "R",3,"WORKCF.TMP",76
2440 FIELD 3,15 AS WCN$,5 AS NC$, 5 AS MC$, 5 AS EF$, 5 AS UF$, 12 AS OC$,12 AS
BC$, 12 AS IC$
2450 FOR I =1 TO T
2460 NC1$ = MKS$(C(I,1)): MC1$ =MKS$(C(I,2)) :EF1$ = MKS$(C(I,3)):UF1$ =MKS$(C(I
,4)):OC1$=MKS$(C(I,5)):BC1$=MKS$(C(I,6)):IC1$=MKS$(C(I,7))
2470 LSET WCN$=W$(I):LSET NC$ =NC1$:LSET MC$ =MC1$:LSET EF$= EF1$:LSET UF$ =UF1$
:LSET OC$=OC1$:LSET BC$=BC1$:LSET IC$=IC1$
2480 PUT 3,I
2490  NEXT I
2500 CLOSE 3
2510 KILL "WORKCF"
2520 NAME "WORKCF.TMP" AS "WORKCF"
2530 REM *** UPDATING THE COMPANY FILE ***
2540 OPEN "I",2,"COMPF"
2550 OPEN "O",3,"COMPF.TMP"
2560   INPUT #2,CN$,NP,NWC,WWY,WHD,WDW,WDM
2570    NWC = T
2580    WRITE #3,CN$,NP,NWC,WWY,WHD,WDW,WDM
2590 CLOSE 2,3
2600 KILL "COMPF"
2610 NAME "COMPF.TMP" AS "COMPF"
2620 COLOR 7,0,0
2630 RETURN
2640 REM *** UPDATING PRODUCTS FILE ***
2650 GOSUB 210
2660 PRINT TAB(20);" PRODUCTS FILE :"
2670 PRINT TAB(20);" ---------------":PRINT
2680 PRINT TAB(25);"1- CREATE NEW PRODUCT FILE"
2690 PRINT TAB(25);"2- ADD NEW PRODUCT "
2700 PRINT TAB(25);"3- UPDATE PRODUCT DATA "
2710 PRINT TAB(25);"4- DELETE PRODUCT "
2720 PRINT TAB(25);"5- EXIT   "
2730 PRINT :PRINT TAB(20);"ENTER CHOICE NO.";:INPUT CN1%
2740 IF  CN1% < 1 OR CN1% > 5 THEN 2750 ELSE 2760
2750 PRINT:PRINT:PRINT "CHOICE NO. MUST BE EITHER 1,2,3,4,OR 5 ":GOSUB 170 :GOTO
  2650
2760 IF CN1% = 5 THEN RETURN
2770 ON CN1% GOSUB  2790,3390,3600,4010
2780 GOTO 2640
2790  REM *** CREATING NEW PRODUCT FILE***
2800 X = 1 :
2810 GOSUB 210
2820 PRINT TAB(20);"ENTER THE NUMBER OF PRODUCTS ( =< 10 )";:INPUT NP
2830 IF NP =< 0 OR NP >10 THEN 2820
2840 T= NP:GOSUB 580 :NP =T :GOSUB 900:REM UPDATING THE COMPANY FILE
2850 GOSUB 210
2860 FOR L = X TO NP
2870 GOSUB 2880 :GOTO 3190
2880 GOSUB 210
2890 PRINT TAB(20);"FOR PRODUCT NO. ";L -X +1
2900 PRINT TAB(20);"----------------- ":PRINT
2910 PRINT TAB(15);"ENTER PRODUCT NAME ( < 30 CHRS )       ";:INPUT PN$(L)
2920 PRINT TAB(15);"ENTER NO. OF OPERATIONS NEEDED FOR PRODUCTION";:INPUT NPC
2930 IF NPC > 10 OR NPC <= 0 THEN PRINT TAB(5);" MAX. NO. OF PRODUCTS CAN'T EXCE
ED 10 OR EQUAL TO 0 ; PLEASE REENTER";:GOTO 2920
2940 FOR I= 1 TO 10
2950   PS(L,I)=0:OT(L,I)=0:PS1(L,I)=0:OT1(L,I)=0:PS2(L,I)=0:OT2(L,I) =0
2960 NEXT I
2970 FOR I = 1 TO NPC
2980 CLS
```

```
2290 FOR I = 1 TO T
2300 IF OP2 = 0 THEN 2340
2310 IF I >= OP2 THEN 2320 ELSE 2340
2320 W$(I) = W$(I+1)
2330 C(I,1) = C(I+1,1) : C(I,2) = C(I+1,2):C(I,3)=C(I+1,3) :C(I,4)=C(I+1,4):C(I,
5)=C(I+1,5):C(I,6)=C(I+1,6):C(I,7)=C(I+1,7)
2340 PRINT TAB(1);I;TAB(6);W$(I);TAB(22);C(I,1);TAB(28);C(I,2);TAB(34);C(I,3);TA
B(41);C(I,4);TAB(48);C(I,5);TAB(55);C(I,6);TAB(66);C(I,7)
2350 NEXT I
2360 PRINT:PRINT TAB(5);"ENTER WORK-CENTER NO. TO DELETE; 0 TO CONTINIUE";:INPUT
 OP2
2370 IF OP2 < 0 OR OP2 > T THEN PRINT TAB(5);"WORK-CENTER MUST BE BETWEEN 1&";T;
" PLEASE REENTER ":GOTO 2360
2380 IF OP2 = 0 THEN  2420 ELSE  2390
2390 PRINT TAB(5);"ARE SURE YOU WANT TO DELETE WORK CENTER # ";OP2;" (Y/N)";:INP
UT Y$
2400 IF Y$ ="Y" OR Y$="y" OR Y$="N" OR Y$="n" THEN 2410 ELSE 2390
2410 IF Y$ ="Y" OR Y$="y" THEN T =T-1 :GOTO 2230 ELSE OP2 = T+1:GOTO 2230
2420 GOSUB 4220 :REM WAITNG MASSAGE
2430 OPEN "R",3,"WORKCF.TMP",76
2440 FIELD 3,15 AS WCN$,5 AS NC$, 5 AS MC$, 5 AS EF$, 5 AS UF$, 12 AS OC$,12 AS
BC$, 12 AS IC$
2450 FOR I =1 TO T
2460 NC1$ = MKS$(C(I,1)): MC1$ =MKS$(C(I,2)) :EF1$ = MKS$(C(I,3)):UF1$ =MKS$(C(I
,4)):OC1$=MKS$(C(I,5)):BC1$=MKS$(C(I,6)):IC1$=MKS$(C(I,7))
2470 LSET WCN$=W$(I):LSET NC$ =NC1$:LSET MC$ =MC1$:LSET EF$= EF1$:LSET UF$ =UF1$
:LSET OC$=OC1$:LSET BC$=BC1$:LSET IC$=IC1$
2480 PUT 3,I
2490  NEXT I
2500 CLOSE 3
2510 KILL "WORKCF"
2520 NAME "WORKCF.TMP" AS "WORKCF"
2530 REM *** UPDATING THE COMPANY FILE ***
2540 OPEN "I",2,"COMPF"
2550 OPEN "O",3,"COMPF.TMP"
2560    INPUT #2,CN$,NP,NWC,WWY,WHD,WDW,WDM
2570     NWC = T
2580     WRITE #3,CN$,NP,NWC,WWY,WHD,WDW,WDM
2590 CLOSE 2,3
2600 KILL "COMPF"
2610 NAME "COMPF.TMP" AS "COMPF"
2620 COLOR 7,0,0
2630 RETURN
2640 REM *** UPDATING PRODUCTS FILE ***
2650 GOSUB 210
2660 PRINT TAB(20);" PRODUCTS FILE :"
2670 PRINT TAB(20);" ---------------":PRINT
2680 PRINT TAB(25);"1- CREATE NEW PRODUCT FILE"
2690 PRINT TAB(25);"2- ADD NEW PRODUCT "
2700 PRINT TAB(25);"3- UPDATE PRODUCT DATA "
2710 PRINT TAB(25);"4- DELETE PRODUCT "
2720 PRINT TAB(25);"5- EXIT    "
2730 PRINT :PRINT TAB(20);"ENTER CHOICE NO.";:INPUT CN1%
2740 IF  CN1% < 1 OR CN1% > 5 THEN 2750 ELSE 2760
2750 PRINT:PRINT:PRINT "CHOICE NO. MUST BE EITHER 1,2,3,4,OR 5 ":GOSUB 170 :GOTO
  2650
2760 IF CN1% = 5 THEN RETURN
2770 ON CN1% GOSUB  2790,3390,3600,4010
2780 GOTO 2640
2790  REM *** CREATING NEW PRODUCT FILE***
2800 X = 1 :
2810 GOSUB 210
2820 PRINT TAB(20);"ENTER THE NUMBER OF PRODUCTS ( =< 10 )";:INPUT NP
2830 IF NP =< 0 OR NP >10 THEN 2820
```

```
2840 T= NP:GOSUB 580 :NP =T :GOSUB 900:REM UPDATING THE COMPANY FILE
2850 GOSUB 210
2860 FOR L = X TO NP
2870 GOSUB 2880 :GOTO 3190
2880 GOSUB 210
2890 PRINT TAB(20);"FOR PRODUCT NO. ";L -X +1
2900 PRINT TAB(20);"----------------- ":PRINT
2910 PRINT TAB(15);"ENTER PRODUCT NAME ( < 30 CHRS )      ";:INPUT PN$(L)
2920 PRINT TAB(15);"ENTER NO. OF OPERATIONS NEEDED FOR PRODUCTION";:INPUT NPC
2930 IF NPC > 10 OR NPC <= 0 THEN PRINT TAB(5);" MAX. NO. OF PRODUCTS CAN'T EXCE
ED 10 OR EQUAL TO 0 ; PLEASE REENTER";:GOTO 2920
2940 FOR I= 1 TO 10
2950   PS(L,I)=0:OT(L,I)=0:PS1(L,I)=0:OT1(L,I)=0:PS2(L,I)=0:OT2(L,I) =0
2960 NEXT I
2970 FOR I = 1 TO NPC
2980 CLS
2990 PRINT TAB(30);"FOR PRODUCT NO. ";L -X +1
3000 PRINT TAB(30);"----------------- ":PRINT
3010 PRINT TAB(5);" OPERATION NO.";I
3020 PRINT TAB(5);"----------------- ":PRINT
3030 PRINT:PRINT TAB(5);"ENTER THE OPERATIONAL WORK-CENTER NO.";:INPUT PS(L,I)
3040 IF PS(L,I) <= 0  THEN PRINT TAB(5);"WORK-CENTER MUST BE > 0 ;PLEASE REENTER
";:GOTO 3030
3050 PRINT TAB(5);"ENTER STANDAR PROCESS TIME IN MAN / MACHINE HOURS";:INPUT OT(
L,I)
3060 IF OT(L,I) <= 0  THEN PRINT TAB(5);"PROCESS TIME MUST BE > 0 ;PLEASE REENTE
R";:GOTO 3050
3070 PRINT TAB(5);"ENTER 1ST ALTERNATIVE WORK-CENTER NO.;0 IF NONE EXIST";:INPUT
 PS1(L,I)
3080 IF PS1(L,I) = 0  THEN 3170
3090 IF PS1(L,I) < 0  THEN PRINT TAB(5);"WORK-CENTER MUST BE >= 0 ;PLEASE REENTE
R";:GOTO 2930
3100 PRINT TAB(5);"ENTER STANDAR PROCESS TIME IN MANHOUR";:INPUT OT1(L,I)
3110 IF OT1(L,I) <= 0  THEN PRINT TAB(5);"PROCESS TIME MUST BE > 0 ;PLEASE REENT
ER";:GOTO 3100
3120 PRINT TAB(5);"ENTER 2ND ALTERNATIVE WORK-CENTER NO.;0 IF NONE EXIST";:INPUT
 PS2(L,I)
3130 IF PS2(L,I) < 0  THEN PRINT TAB(5);"WORK-CENTER MUST BE >= 0 ;PLEASE REENTE
R";:GOTO 3120
3140 IF PS2(L,I) = 0  THEN 3170
3150 PRINT TAB(5);"ENTER STANDAR PROCESS TIME IN MANHOUR";:INPUT OT2(L,I)
3160 IF OT2(L,I) <= 0  THEN PRINT TAB(5);"PROCESS TIME MUST BE > 0 ;PLEASE REENT
ER";:GOTO 3150
3170 NEXT I
3180 RETURN
3190 PRINT:PRINT TAB(5);"THIS PRODUCT HAS BE NUMBERED ";L :GOSUB 170
3200 PRINT
3210 NEXT L
3220 IF FLAG = -1 THEN RETURN
3230 REM *** SAVING DATA TO A FILE ***
3240 GOSUB 3250 :GOTO 3370
3250 GOSUB 4220
3260 OPEN "O",1,"PRODUCTF"
3270 IF FLAG = -2 THEN WRITE #1,NPN ELSE WRITE #1,NP
3280 FOR L = 1 TO NP
3290 IF PN$(L) = "DEL" THEN 3340
3300 WRITE #1,PN$(L)
3310    FOR I = 1 TO 10
3320       WRITE #1,PS(L,I),OT(L,I),PS1(L,I),OT1(L,I),PS2(L,I),OT2(L,I)
3330   NEXT I
3340 NEXT L
3350 CLOSE 1
3360 RETURN
3370 GOSUB 3620
3380 RETURN
3390 REM *** ADDING NEW PRODUCT ***
```

```
3400 FLAG = -1
3410 GOSUB 210
3420 PRINT TAB(20);"ENTER NO. OF NEW PRODUCTS ";:INPUT T
3430 IF T <= 0 OR T >10 THEN 3420
3440 GOSUB 3630 :REM LOADING PRODUCTS FROM FILE
3450  X = NP+1 : NP = NP + T
3460 IF  NP > 10 THEN PRINT:PRINT TAB(20);"THE TOTAL NO. OF PRODUCTS CAN'T EXCEE
D 10 ":PRINT TAB(20);"THE COMPANY HAS ALLREADY ":X-1;" PRODUCTS; PLEASE REENTER"
 :PRINT:GOTO 3420
3470  GOSUB 2860 :REM ADDING NEW PRODUCT
3480  GOSUB 3250 :REM SAVING NEW PRODUCTS
3490 REM *** UPDATING THE COMPANY FILE ***
3500 FLAG = 1
3510 OPEN "I",2,"COMPF"
3520 OPEN "O",3,"COMPF.TMP"
3530    INPUT #2,CN$,NP,NWC,WWY,WHD,WDW,WDM
3540    NP = NP + T
3550    WRITE #3,CN$,NP,NWC,WWY,WHD,WDW,WDM
3560 CLOSE 2,3
3570 KILL "COMPF"
3580 NAME "COMPF.TMP" AS "COMPF"
3590 RETURN
3600 REM *** UPDATING PRODUCT DATA ***"
3610 GOSUB 4220
3620 GOSUB 3630 :GOTO 3740
3630 OPEN "I",1,"PRODUCTF"
3640 INPUT #1,NP
3650 FOR L = 1 TO NP
3660 IF FLAG = -2 THEN NPN = NP
3670 INPUT #1,PN$(L)
3680    FOR I = 1 TO 10
3690       INPUT #1,PS(L,I),OT(L,I),PS1(L,I),OT1(L,I),PS2(L,I),OT2(L,I)
3700   NEXT I
3710 NEXT L
3720 CLOSE 1
3730 RETURN
3740 FOR L =1 TO NP
3750 CLS:PRINT
3760 PRINT TAB(30);"PRODUCTS FILE"
3770 PRINT TAB(30);"--------------":PRINT
3780 REM
3790 PRINT TAB(10);"PRODUCT NO. : ";L;TAB(30);"PRODUCT NAME : ";PN$(L)
3800 FOR I=1 TO 75 :PRINT "-";:NEXT I
3810 PRINT TAB(5);"SEQUENCE";TAB(39);"1ST ALT.";TAB(59);"2ND ALT."
3820 PRINT TAB(5);"OF WORK-CENTERS";TAB(25)"PROCESS";TAB(37);"WORK";TAB(44);"PRO
CESS";TAB(57);"WORK";TAB(64);"PROCESS"
3830 PRINT TAB(5);"(OPERATIONS)";TAB(26);"TIME";TAB(35);"CENTER #";TAB(45)"TIME"
;TAB(55);"CENTER #";TAB(65);"TIME"
3840 FOR I=1 TO 75 :PRINT "-";:NEXT I
3850 FOR I = 1 TO 10
3860 IF PS(L,I) = 0 THEN 3880
3870    PRINT TAB(7);PS(L,I);TAB(26);OT(L,I);TAB(36);PS1(L,I);TAB(46);OT1(L,I);
        TAB(55);PS2(L,I);TAB(65);OT2(L,I)
3880 NEXT I
3890 IF FLAG = -2 THEN 4050
3900 PRINT:PRINT TAB(10);"WOULD YOU LIKE TO MAKE ANY CHANGES ( Y/N) ";:INPUT O$
3910 IF O$ = "Y" OR O$ ="y" OR O$ ="N" OR O$ ="n" THEN 3920 ELSE 3900
3920 IF O$ = "Y" OR O$ = "y" THEN  3930 ELSE  3950
3930 X =1 :GOSUB 2880
3940 GOTO 3750
3950 NEXT L
3960 CLOSE 1
3970 REM *** SAVING DATA AFTER CHANGES ***
3980 KILL "PRODUCTF"
3990 GOSUB 3250
4000 RETURN
4010 REM *** DELETING A PRODUCT ****
4020 FLAG = -2
4030 GOSUB 3600
4040 FLAG = 2 :NP = NPN:GOTO  4100
```

```
4050 PRINT:PRINT TAB(10);"WOULD YOU LIKE TO DELETE THIS PRODUCT ( Y/N) ";:INPUT
O$
4060 IF O$ = "Y" OR O$ ="y" OR O$ ="N" OR O$ ="n" THEN 4070 ELSE 4050
4070 IF O$ = "Y" OR O$ = "y" THEN  4080 ELSE   3950
4080 PN$(L)  = "DEL":NPN = NPN -1
4090 GOTO 3950
4100 REM *** UPDATING THE COMPANY FILE ***
4110 T = NP
4120 OPEN "I",2,"COMPF"
4130 OPEN "O",3,"COMPF.TMP"
4140    INPUT #2,CN$,NP,NWC,WWY,WHD,WDW,WDM
4150    NP = T
4160    WRITE #3,CN$,NP,NWC,WWY,WHD,WDW,WDM
4170 CLOSE 2,3
4180 KILL "COMPF"
4190 NAME "COMPF.TMP" AS "COMPF"
4200 COLOR 7,0,0
4210 RETURN
4220 GOSUB 210:PRINT TAB(30);:COLOR 16,7,0
4230 PRINT "     PLEASE WAIT    ":COLOR 7,0,0
4240 PRINT TAB(30);:COLOR 0,7,0:PRINT " FOR DISK OPERATION "
4250 COLOR 7,0,0
4260 RETURN
4270 REM *** ERROR MASEGES ***
4280 REM
4290 IF ERR = 53 THEN BEEP:GOSUB 210 :PRINT TAB(20);"FILE NOT FOUND; PLEASE CHEC
K THE FILE NAME":GOSUB 170 :RESUME 220
4300 IF ERR = 70 THEN BEEP:GOSUB 210 :PRINT TAB(20);"DISK  WRITE PROTECTED;PLEAS
E REMOVE IT":GOSUB 170 :RESUME 220
4310 IF ERR = 61 THEN BEEP:GOSUB 210 :PRINT TAB(20);"DISK  FULL ":GOSUB 170 :RES
UME 220
4320 IF ERR = 27 THEN BEEP:GOSUB 210 :PRINT TAB(20);"OUT OF PAPER":GOSUB 170 :RE
SUME 220
4330 IF ERR = 55 THEN BEEP:GOSUB 210 :PRINT TAB(20);"FILE ALREADY EXISTS;PLEASE
CHOOSE ANOTHER NAME":GOSUB 170 :RESUME 220
4340 BEEP:ON ERROR GOTO 0
```

```
100 REM *** PROG: CAPACITY***
110 ON ERROR GOTO 5960
120 KEY OFF :OPTION BASE 1 :SCREEN 0,1
130 GOSUB 4500
140 WDM = 20
150 OPEN "R",2,"WORKCF",76
160 FIELD 2,15 AS WCN$,5 AS NC$, 5 AS MC$, 5 AS EF$, 5 AS UF$, 12 AS OC$,12 AS B
C$, 12 AS IC$
170 GOSUB 180 :GOTO 590
180 GOSUB 630
190 PRINT TAB(25);"ENTER RELEASED ORDERS FILE NAME  ";:INPUT F1$
200 PRINT TAB(25);"ENTER PLANNED ORDERS FILE NAME   ";:INPUT F$
210 PRINT TAB(25);"ENTER THE DISK DRIVE ( A,B,OR C )";:INPUT D$
220 IF D$="A" OR D$ ="a" OR D$ ="B" OR D$ ="b" OR D$ ="C" OR D$ ="c" THEN 230 EL
SE 210
230 A$ = D$+":"+F1$ :A1$= D$+":"+F$
240 GOSUB 630
250 PRINT TAB(10);"ENTER PLANNING HORIZON (IN WEEKS)";:INPUT PH
260 IF PH <= 0 THEN 250
270 PRINT TAB(10);"ENTER STARTING WORKING DAY FOR THE PLANNING HORIZON ";:INPUT
CD
280 IF CD <= 0 THEN 270
290 PRINT TAB(10);"ENTER TIME INCREAMENT (BUCKETS FOR REPORTING) :"
300 PRINT TAB(10);"                          1- DAILY 2- WEEKLY 3- MONTHLY";:INPUT
TB
310 IF TB <> 1 AND TB<>2 AND TB <>3 THEN 290
320 IF TB = 1 THEN V$=" DAY " ELSE IF TB = 2 THEN V$="WEEK " ELSE V$="MONTH"
330 REM *** LOADING COMPANY DATA ***
340 GOSUB 4500
350 OPEN "I",1,"COMPF"
360 INPUT #1,CN$,NP,NWC,WWY,WHD,WDW,WDM
370 CLOSE 1
380 IF TB = 2 THEN PH1 = PH
390 IF TB = 3 THEN 400 ELSE 430
400 PH2 = (PH * WDW )/ WDM
410 F1 = PH2 - FIX(PH2)
420 IF F1 > 0 THEN PH1 = PH2+1 ELSE PH1 = PH2
430 PH3=PH*WDW:PH = (PH * WDW ) + CD -1 :PHG=PH
440 DIM L(NWC,PH),L2(NWC,PH)
450 IF TB <> 1 THEN DIM L1(NWC,PH1),L5(NWC,PH1)
460 DIM PN$(NP),PS(NP,10),OT(NP,10),PS1(NP,10),OT1(NP,10),PS2(NP,10),OT2(NP,10)
470 DIM U1(NWC,6)
480 REM *** LOADING PRODUCTS DATA ***
490 OPEN "I",3,"PRODUCTF"
500 INPUT #3,NP
510 FOR I = 1 TO NP
520  INPUT #3,PN$(I)
530  FOR L = 1 TO 10
540      INPUT #3,PS(I,L),OT(I,L),PS1(I,L),OT1(I,L),PS2(I,L),OT2(I,L)
550  NEXT L
560 NEXT I
570 CLOSE 3
580 RETURN
590 GOSUB 670 :REM MAIN MENU
600 CLOSE 2: CLS :CHAIN "MAIN",30,ALL
610 REM
620 REM
630 CLS:FOR I = 1 TO 10:PRINT:NEXT I :RETURN
640 PRINT:COLOR 14,0,0:PRINT "HIT ANY KEY TO CONTINUE " :COLOR 7,0,0
650 Y$ = INKEY$ :IF Y$ ="" THEN 650
660 RETURN
670 CLS
680 FOR I =1 TO 7 :PRINT:NEXT I
```

```
690 PRINT TAB(20); "LOADING / PLANNING POLICY :"
700 PRINT TAB(20); "--------------------------":PRINT
710 PRINT TAB(25);"1- FORWARD LOADING "
720 PRINT TAB(25);"2- BACKWARD LOADING "
730 PRINT TAB(25);"3- ORDERS SPLITTING "
740 'PRINT TAB(25);"4- GRAPHING THE RESULT"
750 PRINT TAB(25);"4- EXIT TO MAIN "
760 PRINT:PRINT TAB(20);"ENTER CHOICE NO.";:INPUT CN%
770 IF CN% < 1 OR CN% > 4 THEN 780 ELSE 790
780 PRINT:PRINT "CHOICE NO. MUST BE EITHER 1,2,3,OR 4":GOTO 760
790 IF CN% = 4 THEN RETURN
800 ON CN% GOSUB 820,2820,4990
810 GOTO 670
820 REM *** FORWARD SCHEDULING ****
830 REM
840 IF Y1 > 0 THEN 860 ELSE 910
850 'ERASE L,L2,D,U1
860  ERASE L,L2,D,U1,PS,OT,PS1,OT1,PS2,OT2,PN$
870 IF TB <> 1 THEN ERASE L1,L5
880 'DIM L(NWC,PHG),L2(NWC,PHG),U1(NWC,6)
890 'IF TB <> 1 THEN DIM L1(NWC,PH1),L5(NWC,PH1)
900 GOSUB 180
910 GOSUB 4560
920 REM *** LOADING ORDERS DATA ***
930 REM OPEN "R",2,"WORKCF",40
940 REM FIELD 2,30 AS WCN$,5 AS NC$ ,5 AS MC$
950 OPEN "I",1,A$
960 OPEN "I",3,A1$
970 INPUT #1,NW
980 INPUT #3,NW1
990 NT = NW + NW1 :NT1 = NT
1000 DIM D(NT,7)
1010 V1$="RELEASED"
1020  FOR L = 1 TO NT
1030      IF L > NW THEN INPUT #3,N,PT,OQ,DD,SD,C1,C2 :V1$="PLANNED":GOTO 1050
1040      INPUT #1,N,PT,OQ,DD,SD,C1,C2
1050 GOSUB 1060 :GOTO 1450
1060      R = DD - SD
1070      TH = R * WHD
1080      S = SD + CD
1090 REM PRINT S :GOSUB 420
1100 IF S > PHG THEN BEEP:GOSUB 630 :PRINT TAB(20);"ORDER NO. ";N;" OF ";V1$;" F
ILE HAS STARTING DATE BEYOND";:PRINT TAB(20);" THE DATE OF THE STUDY; PLEASE";:P
RINT TAB(20);"CHANGE THE STARTING DATE OF THE ORDER" :GOSUB 640 :CLOSE 1,3:RETUR
N
1110  REM HW = NC * WDW
1120      Z = 0 : T = 0 :Y1 = 0
1130   Z = S-1 :REM PRINT Z:GOSUB 420
1140   FOR I = 1 TO NWC
1150      X = PS(PT,I)
1160      IF X = 0 THEN 1410
1170      GET 2,X
1180 NC = CVS(NC$) : MC = CVS(MC$): EF= CVS(EF$):UF=CVS(UF$):OCA= CVS(OC$):BC= C
VS(BC$):IC= CVS(IC$)
1190      EU = (EF/100)*(UF/100): NC = INT((EU*NC)*100)/100
1200      HW = NC
1210      Y = OT(PT,I) * OQ
1220      Y1 = Y1 + Y :'LPRINT Y1,X,L
1230 REM PRINT Y1 ,Y ,HW :GOSUB 420
1240 REM IF S > 0 THEN Z = S-1 :PRINT Z:GOSUB 420:REM Q = (S/WDW)-Z :IF Q > 0 TH
EN HW1 = HW:HW = HW * Q :PRINT Z,Q :GOSUB 420
1250      REM IF T > 0 AND S > 0 THEN Z=Z+1 :T1=HW - T : Y = Y - T1 :T = 0 :GOTO
 1156
1260      IF T > 0 THEN  Y = Y - T :GOTO 1320
1270      Z = Z + 1
1280       IF Z > PH THEN Z = -1 :GOTO 1430
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```
1290          Y = Y - HW
1300          GOTO 1360
1310      REM IF Y <= 0 THEN  L(X,Z) = L(X,Z) + Y +T1:T = Y+T1 :GOTO 1185
1320          IF Y <= 0 AND HW >= T+Y THEN  L(X,Z) = L(X,Z) + Y +T:T =Y+T-HW:
              IF L <= NW THEN L2(X,Z)=L(X,Z):GOTO 1400  ELSE 1400
1330          IF Y <= 0 THEN  L(X,Z) = L(X,Z) +HW:Y= Y+T-HW:GOTO 1380
1340          IF T >HW THEN L(X,Z) = L(X,Z) +HW:Y=Y+T-HW:T =0: GOTO 1380
1350          L(X,Z) = L(X,Z) +T:T =0: GOTO 1380
1360          IF Y <= 0 THEN  L(X,Z) = L(X,Z) + Y+HW:T =-Y :IF L <= NW THEN L2(X,Z
)= L(X,Z):GOTO 1400 ELSE 1400
1370          L(X,Z) = L(X,Z) + HW
1380 REM PRINT PT,X,Z,L(X,Z) :GOSUB 420
1390        IF L <= NW THEN L2(X,Z)=L(X,Z):GOTO 1270 ELSE 1270
1400 REM  PRINT PT,X,Z,L(X,Z) :GOSUB 420
1410    NEXT I
1420 REM  PRINT PT,X,Z,L(X,Z) :GOSUB 420
1430  D(L,1) = N:D(L,2)=DD+CD:D(L,3)=SD+CD:D(L,4)=Z :D(L,5)=C1:D(L,6)=C2:D(L,7)=
OQ:REM EARLIEST FINISH OF ORDER L
1440 RETURN
1450 NEXT L
1460 CLOSE 1,3
1470 GOSUB 4620
1480 GOSUB 630
1490 IF CN% =2 THEN  PRINT TAB(20);"LOADING POLICY    :BACKWARD":GOTO 1510 ELSE 1
500
1500      PRINT TAB(20);"LOADING POLICY  :FORWARD "
1510      PRINT TAB(20);"-----------------"
1520 PRINT TAB(20); "REPORTS OPTIONS :"
1530 PRINT TAB(20); "-----------------"
1540 PRINT TAB(25);"1- WORK-CENTERS LOAD PROFILE"
1550 PRINT TAB(25);"2- RELEASED ORDERS STATUS"
1560 PRINT TAB(25);"3- PLANNED OREDRS STATUS"
1570 PRINT TAB(25);"4- LOADING POLICY PREFORMANCE "
1580 PRINT TAB(25);"5- GRAPHING THE RESULT"
1590 PRINT TAB(25);"6- PRINTING THE RESULT"
1600 PRINT TAB(25);"7- EXIT TO MAIN MENU"
1610 PRINT:PRINT TAB(20);"ENTER CHOICE NO.";:INPUT CN1%
1620 IF CN1% < 1 OR CN1% > 7 THEN 1630 ELSE 1640
1630 PRINT:PRINT "CHOICE NO. MUST BE EITHER 1,2,3,4,5,6 OR 7":GOTO 1610
1640 IF CN1% = 7 THEN RETURN
1650 ON CN1% GOSUB 1670,2120,2120,2410,3440,6290
1660 GOTO 1480
1670 REM *** DISPLAYING RESULT ***
1680 REM
1690 CLS :PRINT
1700 FOR L = 1 TO NWC
1710  OC = 0 :UC = 0 :H = 0 : H1 = 0:C1 = 1
1720 IF TB <> 1 THEN PH = PH1 :K=1 ELSE K = CD
1730 GET 2,L
1740 NC = CVS(NC$) : MC = CVS(MC$): EF= CVS(EF$):UF=CVS(UF$):OCA= CVS(OC$):BC= C
VS(BC$):IC= CVS(IC$):K = CD
1750       EU = (EF/100)*(UF/100)
1760 IF TB = 2 THEN NC = INT(((NC *WDW)*EU)*100)/100 :MC = INT(((MC *WDW)*EU)*10
0)/100
1770 IF TB = 3 THEN NC = INT(((NC *WDM)*EU)*100)/100 :MC = INT(((MC *WDM)*EU)*10
0)/100
1780 IF TB = 1 THEN NC = INT(((NC )*EU)*100)/100 :MC = INT(((MC )*EU)*100)/100
1790 'IF FLAG = -9 THEN 3070
1800 IF CN% =2 THEN COLOR 2,0,0: PRINT TAB(30);"LOADING POLICY    :BACKWARD":GOTO
 1820 ELSE 1810
1810      COLOR 2,0,0: PRINT TAB(30);"LOADING POLICY    :FORWARD "
1820      PRINT TAB(30);"------------------":COLOR 7,0,0
1830 PRINT TAB(30);"WORK-CENTER NAME : ";:COLOR 2,0,0:PRINT WCN$ :COLOR 7,0,0
1840 PRINT TAB(30);"--------------------"
1850 PRINT "NORMAL CAPACITY (PER ";V$") = "; NC ;TAB(40);"MAXIMUM CAPACITY (PER
"V$;") = ";MC
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1860 PRINT "EFFECIENCY FACTOR              = "; EF;"%" ;TAB(40);"UTILIZATION FACTOR
          = ";UF;"%"
1870 PRINT "OVER-MAX COST/HR.= ";OCA;TAB(27);"BTWN MAX & NOR. COST/HR.=";BC;TAB(
59);"IDLE COST /HR. =";IC
1880 COLOR 14,0,0:FOR I =1 TO 79 :PRINT "-";:NEXT I :COLOR 7,0,0 :PRINT
1890  PRINT V$;TAB(10);"REQUIRED";TAB(25);"LOAD";TAB(32);"% UTILIZED";:COLOR 4,0
,0:PRINT TAB(45);"O";:COLOR 7,0,0:PRINT TAB(47);"= OVER LOADED";:COLOR 12,0,0 :P
RINT TAB(63);"U";:COLOR 7,0,0 :PRINT TAB(65);"= UNDER LOADED"
1900  PRINT " NO.";TAB(10);"CAPACITY";TAB(24);"STATUS";:COLOR 2,0,0:PRINT TAB(45
);"N";:COLOR 7,0,0:PRINT TAB(47);"= NORMAL LOAD"
1910 COLOR 14,0,0:FOR I =1 TO 80 :PRINT "-";:NEXT I :COLOR 7,0,0
1920 C =0
1930 'IF TB <> 1 THEN PH = PH1 :K=1 ELSE K = CD
1940   FOR I = K TO PH
1950 IF TB = 1 THEN 2010
1960 PRINT;TAB(3);I;TAB(10);CINT(L1(L,I));:IF L1(L,I) > MC THEN COLOR 20,0,0:PRI
NT TAB(25);"O";:COLOR 7,0,0 :GOTO 1990
1970 IF L1(L,I) < NC THEN COLOR 12,0,0:PRINT TAB(25);"U";:COLOR 7,0,0 :GOTO 1990

1980  COLOR 2,0,0:PRINT TAB(25);"N";:COLOR 7,0,0
1990 U = CINT((L1(L,I) / (NC ))*100)
2000 GOTO 2050
2010 PRINT;TAB(3);I;TAB(10);CINT(L(L,I));:IF L(L,I) > MC THEN COLOR 20,0,0:PRINT
 TAB(25);"O";:COLOR 7,0,0 GOTO 2040
2020 IF L(L,I) < NC THEN COLOR 12,0,0:PRINT TAB(25);"U";:COLOR 7,0,0 :GOTO 2040
2030  COLOR 2,0,0:PRINT TAB(25);"N";:COLOR 7,0,0
2040 U = CINT((L(L,I) / (NC ))*100)
2050 PRINT TAB(35);U
2060 C = C + 1
2070 IF C = 10 AND I< PH THEN GOSUB 640 :C =0  : K = I+1 :CLS:GOTO 1800
2080  NEXT I
2090 GOSUB 640 :CLS
2100 NEXT L
2110 RETURN
2120 REM *** ORDER STATUS REPORT ***
2130 REM
2140 IF CN1%= 2 THEN V1$="RELEASED" ELSE V1$= "PLANNED"
2150 IF CN1%= 2 THEN K=1 :NT = NW  ELSE K = NW +1 :NT = NT1
2160 C = 0
2170     CLS:PRINT
2180 IF CN% =2 THEN COLOR 2,0,0: PRINT TAB(30);"LOADING POLICY :BACKWARD ":GOTO
2200 ELSE 2190
2190     COLOR 2,0,0: PRINT TAB(30);"LOADING POLICY:FORWARD"
2200     PRINT TAB(30);"---------------" :COLOR 7,0,0
2210     COLOR 2,0,0: PRINT TAB(30);V1$;" ORDERS STATUS REPORT"
2220     PRINT TAB(30);"----------------------------" :COLOR 7,0,0
2230 PRINT TAB(8);:COLOR 14,0,0:FOR L = 1 TO 70:PRINT"-";:NEXT L :COLOR 7,0,0:PR
INT
2240     PRINT TAB(10);"ORDER";TAB(17);"DUE ";TAB(24);"STARTING";
2250    IF CN% = 1 THEN PRINT;TAB(35);"EARLIEST";TAB(45);"EARLIEST";TAB(55);"SLA
CK";TAB(65);"DELAY/EARLY" ELSE PRINT TAB(35);"LATEST";TAB(45);"LATEST";TAB(55);"
SLACK"; TAB(65);"(DELAY/EARLY) "
2260     PRINT TAB(10);"  NO.";TAB(17);"DATE";TAB(24);"DATE";TAB(35);" START  ";
TAB(45);"FINISH";TAB(55);"# DAYS";TAB(69);"COST"
2270 PRINT TAB(8);:COLOR 14,0,0:FOR L = 1 TO 70:PRINT"-";:NEXT L :COLOR 7,0,0:PR
INT
2280 FOR I = K TO NT
2290    PRINT TAB(10);D(I,1);TAB(17);D(I,2);TAB(25);D(I,3);
2300 IF D(I,4) = -1 THEN COLOR 12,0,0:PRINT TAB(45);"EBH";:COLOR 7,0,0:PRINT TAB
(55);"*";TAB(69);"*":GOTO 2350
2310    IF CN%=1 THEN PRINT TAB(35);D(I,3);TAB(45);D(I,4);TAB(55);D(I,2)-D(I,4);
 ELSE IF D(I,4)>D(I,2) THEN PRINT TAB(35);D(I,3);TAB(45);D(I,4); TAB(55);D(I,2)-
D(I,4); ELSE PRINT TAB(35);D(I,4);TAB(45);D(I,2);TAB(55);D(I,4)-D(I,3);
2320 IF CN%= 1 THEN CO = D(I,2)-D(I,4):GOTO 2330 ELSE 2340
2330 IF CO < 0 THEN PRINT TAB(69);INT((-CO*D(I,5)*D(I,7)*100))/100 ELSE PRINT TA
B(69);INT((CO*D(I,6)*D(I,7)*100))/100 :GOTO 2350
2340 IF CN% = 2 THEN CO = D(I,2)-D(I,4) :IF CO < 0 THEN CO1=-INT((CO*D(I,5)*D(I,
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7))*100)/100 :PRINT TAB(69);C01 ELSE PRINT TAB(70);0
2350     C = C + 1
2360     'IF I = NW THEN V1$="PLANNED":K =I+1:C=0 :GOSUB 1070:GOTO 3750
2370     IF C = 10 AND I < NT THEN GOSUB 640 : K = I + 1:C = 0:GOTO 2170
2380 NEXT I
2390 GOSUB 640
2400  RETURN
2410 REM *** POLICY  STAT. ***
2420 REM
2430 C = 0 :BMN1=0:DD1=0:OV1=0:AC1=0:GOC=0:IC2=0:BC2=0:OCA2=0:Y=.001
2440 IF TB <> 1 THEN PH = PH1
2450     CLS:PRINT
2460 IF CN% =2 THEN COLOR 2,0,0: PRINT TAB(30);"LOADING POLICY :BACKWARD ":GOTO
2480 ELSE 2470
2470     COLOR 2,0,0: PRINT TAB(30);"LOADING POLICY :FORWARD "
2480     PRINT TAB(30);"---------------" :COLOR 7,0,0
2490 COLOR 14,0,0:FOR L = 1 TO 78:PRINT"-";:NEXT L :COLOR 7,0,0:PRINT
2500  '  PRINT TAB(1);"WORK-CENTER";TAB(20);"# OF ";V$;TAB(35);" AVERAGE";TAB(50
);"# OF ";V$;;TAB(65);"AVERAGE"
2510   PRINT "WORK-CENTER";TAB(16);"  % BTWN";TAB(25);"  %    ";TAB(34);"  %  ";
TAB(43);"OPERATIONAL COST "
2520     PRINT "    NAME    ";TAB(17);"MAX&NOR";TAB(26);"IDLE";TAB(32);"OVER-MAX"
;TAB(42);"IDLE";TAB(49);"OVER-MAX";TAB(59)"BTWN. MAX&NOR";TAB(74);"TOTAL"
2530 COLOR 14,0,0:FOR L = 1 TO 78:PRINT"-";:NEXT L :COLOR 7,0,0:PRINT
2540 FOR I = 1 TO NWC
2550 GET 2,I
2560 NC = CVS(NC$) : MC = CVS(MC$): EF= CVS(EF$):UF=CVS(UF$):OCA= CVS(OC$):BC= C
VS(BC$):IC= CVS(IC$)
2570      EU = (EF/100)*(UF/100)
2580  NC = INT(((NC )*EU)*100)/100 :MC = INT(((MC )*EU)*100)/100
2590 TC = U1(I,1)+U1(I,3)+U1(I,5)
2600 TCN = NC * PH3
2610 ID = TCN - U1(I,3)
2620 BMN= CINT((U1(I,5)/TCN)*100): DD=CINT((ID/TCN)*100):OV=CINT((U1(I,1)/TCN)*1
00):AC=CINT((TC/PH))
2630 IC1= CINT(IC*ID):BC1=CINT(BC*U1(I,5)):OCA1=CINT(OCA*U1(I,1))
2640 TOC = IC1+BC1+OCA1 :GOC =GOC+ TOC
2650     PRINT WCN$; TAB(17);BMN;TAB(26);DD;TAB(32);OV;TAB(42);IC1;TAB(49);OCA1;T
AB(64);BC1;TAB(74);TOC
2660 BMN1 =BMN1+BMN:DD1 = DD1 +DD:OV1=OV1+OV:AC1=AC1+AC:IC2=IC2+IC1:BC2=BC2+BC1:
OCA2=OCA2+OCA1
2670     C = C + 1
2680     IF C = 5 AND I < NWC THEN GOSUB 640 : K = I + 1:C = 0:GOTO 2450
2690 NEXT I
2700 COLOR 14,0,0:FOR L = 1 TO 78:PRINT"-";:NEXT L :COLOR 7,0,0:PRINT
2710 B = I -1
2720 'UT1 =UT1 +Y :DD1 = DD1 +Y:OV1=OV1+Y:AC1=AC1+Y:IC2=IC2+Y:BC2=BC2+Y:OCA2=OCA
2+Y
2730 'PRINT "OVER ALL AVERAGE ";TAB(17);CINT((AC/B)*100)/100;TAB(26);CINT((DD1/B
)*100)/100;TAB(32);CINT((OV1/B)*100)/100;TAB(43);CINT((IC2/B)*100)/100:;TAB(49);
CINT((OCA2/B)*100)/100;TAB(59);CINT((BC2/B)*100)/100;TAB(74);CINT((GOC/B)*100)/1
00
2740 PRINT "OVERALL AVERAGE ";TAB(17);INT((BMN1/B));TAB(26);INT((DD1/B));TAB(32)
;INT((OV1/B));TAB(42);INT((IC2/B));TAB(49);INT((OCA2/B));TAB(64);INT((BC2/B));TA
B(74);INT((GOC/B))
2750 COLOR 14,0,0:FOR L = 1 TO 78:PRINT"=";:NEXT L :COLOR 7,0,0:PRINT
2760 PRINT"TOTAL OPERATIONAL  COST";TAB(70);GOC
2770 PRINT"TOTAL DELAY/EARLY DELIVERY COST";TAB(70);ORC
2780 COLOR 14,0,0:FOR L = 1 TO 78:PRINT"=";:NEXT L :COLOR 7,0,0:PRINT
2790 PRINT"LOADING POLICY GRAND TOTAL COST";:COLOR 4,0,0:PRINT TAB(70);ORC+GOC :
COLOR 7,0,0
2800 GOSUB 640
2810 RETURN
2820 REM *** BACWARD SCHEDULING ***
2830 REM
2840 IF Y1> 0 THEN 2850 ELSE 2900
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```
2850  ERASE L,L2,D,U1,PS,OT,PS1,OT1,PS2,OT2,PN$
2860 IF TB <> 1 THEN ERASE L1,L5
2870 'DIM L(NWC,PHG),L2(NWC,PHG),U1(NWC,6)
2880 'IF TB <> 1 THEN DIM L1(NWC,PH1),L5(NWC,PH1)
2890  GOSUB 180
2900 GOSUB 4560
2910 REM *** LOADING ORDERS DATA ***
2920 REM IF Y1 > 0 THEN 3050
2930 REM OPEN "R",2,"WORKCF",40
2940 REM FIELD 2,30 AS WCN$,5 AS NC$ ,5 AS MC$, 5 AS EF$, 5 AS UF$
2950 OPEN "I",1,A$
2960 OPEN "I",3,A1$
2970 INPUT #1,NW
2980 INPUT #3,NW1
2990 NT = NW + NW1 :NT1 = NT
3000 DIM D(NT,7)
3010 V1$="RELEASED"
3020  FOR L = 1 TO NT
3030      IF L > NW THEN INPUT #3,N,PT,OQ,DD,SD,C1,C2 :V1$="PLANNED":GOTO 3050
3040      INPUT #1,N,PT,OQ,DD,SD,C1,C2
3050      R = DD - SD
3060      DS = DD+CD
3070      S = SD + CD
3080 IF DS >PHG THEN BEEP:GOSUB 630 :PRINT TAB(20);V1$;" ORDER NO. ";N;" HAS DUE
 DATA BEYOND";:PRINT TAB(20);"THE PLANNING HORIZON; PLEASE";:PRINT TAB(20);"CHAN
GE THE DUE DATE OF THE ORDER";:PRINT TAB(20);"OR THE PLANNING HORIZON" :GOSUB 64
0 :CLOSE 1,3
3090 IF S > PHG THEN GOSUB 310 :PRINT TAB(20);"ORDER NO. ";N;" HAS STARTING DATA
 EARLIER";:PRINT TAB(20);"THAN THE DATE OF THE STUDY; PLEASE";:PRINT TAB(20);"CH
ANGE THE STARTING DATE OF THE ORDER" :GOSUB 640 :CLOSE 1,3:RETURN
3100      Z = DD+CD+1 : T = 0 :Y1 = 0
3110   FOR I = NWC TO 1 STEP -1
3120      X = PS(PT,I)
3130      IF X = 0 THEN 3350
3140      GET 2,X
3150 NC = CVS(NC$) : MC = CVS(MC$): EF= CVS(EF$):UF=CVS(UF$):OCA= CVS(OC$):BC= C
VS(BC$):IC= CVS(IC$)
3160      EU = (EF/100)*(UF/100): NC = INT((EU*NC)*100)/100
3170      HW = NC
3180      Y = OT(PT,I) * OQ
3190      Y1 = Y1 + Y :'LPRINT Y1,X,L
3200 REM  IF S > 0 THEN Z = INT(S/WDW) :PRINT Z:GOSUB 420:Q = (S/WDW)-Z :IF Q >
0 THEN HW1 = HW:HW = HW * Q :PRINT Z,Q :GOSUB 420
3210  REM      IF T > 0 AND S > 0 THEN Z=Z+1 :T1=HW - T : Y = Y - T1 :T = 0 :
                                                                  GOTO 3156
3220      IF T > 0 THEN  Y = Y - T  :GOTO 3270
3230      Z = Z - 1
3240      IF Z <S  THEN GOSUB 6040 :GOSUB 1060:GOTO 3380 ELSE 3250
3250        Y = Y - HW
3260        GOTO 3310
3270        IF Y <= 0 AND HW >= T+Y THEN  L(X,Z) = L(X,Z) + Y +T:T =Y+T-HW:
            IF L <= NW THEN L2(X,Z)=L(X,Z):GOTO 3340  ELSE 3340
3280        IF Y <= 0 THEN  L(X,Z) = L(X,Z) +HW:Y= Y+T-HW:GOTO 3330
3290        IF T >HW THEN L(X,Z) = L(X,Z) +HW:Y=Y+T-HW:T =0: GOTO 3330
3300        L(X,Z) = L(X,Z) + T :GOTO 3330
3310        IF Y <= 0 THEN  L(X,Z) = L(X,Z) + Y+HW:T =-Y :IF L <= NW THEN L2(X,Z
)= L(X,Z):GOTO 3340 ELSE 3340
3320        L(X,Z) = L(X,Z) + HW
3330      IF L <= NW THEN L2(X,Z)=L(X,Z):GOTO 3230 ELSE 3230
3340  REM PRINT PT,X,Z,L(X,Z) :GOSUB 420
3350   NEXT I
3360  REM PRINT PT,X,Z,L(X,Z) :GOSUB 1070
3370  D(L,1) = N:D(L,2)=DD+CD:D(L,3)=SD+CD:D(L,4)=Z :D(L,5)=C1:D(L,6)=C2:D(L,7)=
OQ:REM EARLIEST START OF ORDER L
3380 NEXT L
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3390 CLOSE 1,3
3400 GOTO 1470
3410 REM ***ZEROING THE ACCUML. ***
3420 'IF KK = 1 THEN
3430 '    L(X,DS) =
3440 CLS :REM *** GRAPHING THE LOAD PROFILE ***
3450 P = 0 : U = CD :X1 = 0 :X2 = 0 :XX= 0
3460 GOSUB 4560
3470 FOR L = 1 TO NWC
3480 GET 2,L
3490 NC = CVS(NC$) : MC = CVS(MC$): EF= CVS(EF$):UF=CVS(UF$):OCA= CVS(OC$):BC= C
VS(BC$):IC= CVS(IC$)
3500 REM 'IF TB = 2 THEN NC = NC * WDW :MC = MC * WDW
3510 REM 'IF TB = 3 THEN NC = NC * WDM :MC = MC * WDM
3520       EU = (EF/100)*(UF/100)
3530 IF TB = 2 THEN NC = INT(((NC *WDW)*EU)*100)/100 :MC = INT(((MC *WDW)*EU)*10
0)/100
3540 IF TB = 3 THEN NC = INT(((NC *WDM)*EU)*100)/100 :MC = INT(((MC *WDM)*EU)*10
0)/100
3550 IF TB = 1 THEN NC = INT(NC *EU*100)/100 :MC = INT(MC *EU*100)/100
3560  IF TB <> 1 THEN PH = PH1 :CD = 1:U = 1
3570 FOR I = CD TO PH
3580   IF TB = 1 THEN 3590 ELSE 3620
3590   IF I = CD AND L = 1 THEN  H1 = L(L,I)
3600   IF L(L,I) > H1 THEN H1 =L(L,I)
3610 GOTO 3640
3620   IF I = 1 AND L = 1 THEN  H1 = L1(L,I)
3630   IF L1(L,I) > H1 THEN H1 =L1(L,I)
3640 NEXT I
3650 IF MC > H1 THEN H1 = MC
3660 NEXT L
3670 XR = H1
3680 SCREEN 2
3690 FOR L = 1 TO NWC
3700  GET 2,L
3710 NC = CVS(NC$) : MC = CVS(MC$): EF= CVS(EF$):UF=CVS(UF$):OCA= CVS(OC$):BC= C
VS(BC$):IC= CVS(IC$)
3720       EU = (EF/100)*(UF/100)
3730 IF TB = 2 THEN NC = INT(((NC *WDW)*EU)*100)/100 :MC = INT(((MC *WDW)*EU)*10
0)/100
3740 IF TB = 3 THEN NC = INT(((NC *WDM)*EU)*100)/100 :MC = INT(((MC *WDM)*EU)*10
0)/100
3750 IF TB = 1 THEN NC = INT((NC *EU)*100)/100 :MC = INT(((MC )*EU)*100)/100
3760 LINE (72,163)-(72,20)
3770 LINE (72,163)-(600,163)
3780 S1 = 143/ XR
3790 YU = 163 - CINT ((MC )* S1)
3800 YL = 163 - CINT((NC )* S1 )
3810 FOR I= 72 TO 591 STEP 15 :II=I+10:LINE (I,YU)-(II,YU) :NEXT I:YU1 = CINT (Y
U/7.92)
3820 FOR I = 72 TO 591 STEP 15:II = I+10:LINE (I,YL)-(II,YL) :NEXT I:YL1 = CINT
(YL/7.92)
3830 LOCATE YU1,77 :PRINT "MAX"
3840 LOCATE 1,1 :PRINT "CAPACITY"
3850 LOCATE 2,1 :PRINT "(HOURS)"
3860 IF CN% =2 THEN LOCATE 1,30: PRINT TAB(30);"LOADING POLICY :BACKWARD ":GOTO
3880 ELSE 3870
3870      LOCATE 1,30: PRINT ;"LOADING POLICY :FORWARD "
3880 LOCATE 2,30:PRINT "WORK CENTER: ";WCN$
3890 LOCATE YL1,74 :PRINT "NORMAL"
3900 C1$=CHR$(&HAA)
3910  C$=CHR$(&H81)+CHR$(&H42)+CHR$(&H24)+CHR$(&H18)+CHR$(&H18)+CHR$(&H24)+CHR$(
&H42)+CHR$(&H81)
3920 LOCATE 23,74 :PRINT V$
3930 LINE (240,176)-(260,184),1,B:PAINT(245,180),C1$,1
3940 LOCATE 23,35:PRINT"RELEASED";
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```
3950 LINE (360,176)-(380,184),1,B:PAINT(365,180),C$,1
3960 LOCATE 23,50:PRINT"PLANNED"
3970  REM STOP
3980  MC1 = INT ((MC  )* 100) /100
3990 NC1 =  INT ((NC  )*100 )/100
4000 LOCATE YU1,1 :PRINT MC1
4010 LOCATE YL1,1 :PRINT NC1
4020  REM IF TB <> 1 THEN PH = PH1
4030 IF PH > 15 THEN S3 = FIX(65 /15)   ELSE S3 = FIX(65 /(PH))
4040 IF PH > 15 THEN S2 = 518/15 ELSE S2 = 519 / (PH)
4050 FOR I = U TO PH
4060    P = P + 1
4070   IF TB =1 THEN Y = L(L,I) :Y2=L2(L,I) ELSE Y = L1(L,I):Y2=L5(L,I)
4080   Y1 = 163 - CINT(( Y ) * S1)
4090   Y5 = 163 - CINT(( Y2 ) * S1)
4100  X1 =  72 + (S2 * P)
4110 'ST =(S3*P)+9
4120 ' LOCATE 22,ST:PRINT I;
4130   REM LOCATE 21,ST:PRINT "+";
4140  IF P > 1 THEN X2 = X1 - S2 +5 ELSE X2 = X1 -S2+5
4150  X3 = X2 + (S2/2)
4160    LINE (X2,Y1)-(X1,163),1,B
4170    LINE (X2,Y5)-(X1,Y5),1
4180 C1$=CHR$(&HAA)
4190 'C1$=CHR$(&H80)+CHR$(&H1)+CHR$(&H1)+CHR$(&H1)+CHR$(&H1)+CHR$(&H1)+CHR$(&H1)
+CHR$(&H80)
4200  C$=CHR$(&H81)+CHR$(&H42)+CHR$(&H24)+CHR$(&H18)+CHR$(&H18)+CHR$(&H24)+CHR$(
&H42)+CHR$(&H81)
4210 IF Y1< 160 THEN 4220 ELSE 4300
4220  REM   C1$ :XX = 0
4230  IF Y5 < 160 THEN PAINT (X3,160),C1$,1 ELSE 4260
4240  IF Y5 < YL THEN IF YL-Y5 >3 THEN Y3= YL - 2:PAINT (X3,Y3),C1$,1
4250  IF Y5 < YU THEN IF YU-Y5 >3 THEN Y4= YU - 2:PAINT (X3,Y4),C1$,1
4260  IF Y1 < Y5 THEN 4270  ELSE 4300
4270  IF Y5-Y1 >3 THEN Y6= Y5 - 2:PAINT (X3,Y6),C$,1  ELSE 4300
4280  IF Y1 < YL AND YL < Y5 THEN IF YL-Y1 >3 THEN Y3= YL - 2:PAINT (X3,Y3),C$,1

4290  IF Y1 < YU AND YU < Y5 THEN IF YU-Y1 >3 THEN Y4= YU - 2:PAINT (X3,Y4),C$,1

4300    LINE (X3,163)-(X3,158)
4310  ST =CINT(X3/7.988)
4320  LOCATE 22,ST:PRINT I;
4330 'X2 = X1
4340  IF P = 15 AND I < PH THEN GOSUB 4440 ELSE 4370
4350  CLS : U = U + P :P = 0
4360  GOTO 3760
4370 NEXT I
4380 IF TB <> 1 THEN  CD = 1
4390 U = CD : P =0 :X1 = 0 :X2 = 0
4400 GOSUB 4440
4410 CLS
4420 NEXT L
4430 GOTO 4480
4440 LOCATE 23,5 :PRINT "HIT ANY KEY TO CONTINUE "
4450 Y$ = INKEY$
4460 IF Y$= "" THEN 4450
4470 RETURN
4480 SCREEN 0,1
4490 RETURN
4500 GOSUB 630:PRINT TAB(35);:COLOR 16,7,0
4510 PRINT "     PLEASE WAIT     " :COLOR 7,0,0
4520 PRINT TAB(35);:COLOR 0,7,0
4530 PRINT TAB(35);" FOR DISK OPERATION "
4540 COLOR 7,0,0
4550 RETURN
4560 GOSUB 630:PRINT TAB(35);:COLOR 16,7,0
```

```
4570 PRINT "     PLEASE WAIT     " :COLOR 7,0,0
4580 PRINT TAB(35);:COLOR 0,7,0
4590 PRINT TAB(35);"      COMPUTING      "
4600 COLOR 7,0,0
4610 RETURN
4620 REM *** LOAD STAT. ***
4630 FOR L = 1 TO NWC
4640  OC = 0 :UC = 0 :H = 0 : H1 = 0:C1 = 1 :CN = 0:H3=0
4650 GET 2,L
4660 NC = CVS(NC$) : MC = CVS(MC$): EF= CVS(EF$):UF=CVS(UF$):OCA= CVS(OC$):BC= C
VS(BC$):IC= CVS(IC$)
4670       EU = (EF/100)*(UF/100)
4680 IF TB = 2 THEN NC = INT(((NC *WDW)*EU)*100)/100 :MC = INT(((MC *WDW)*EU)*10
0)/100
4690 IF TB = 3 THEN NC = INT(((NC *WDM)*EU)*100)/100 :MC = INT(((MC *WDM)*EU)*10
0)/100
4700 IF TB = 1 THEN NC = INT(((NC )*EU)*100)/100 :MC = INT(((MC )*EU)*100)/100
4710 CP =0 :CP1=0:K = CD :V=0
4720   FOR I = K TO PHG
4730 V= V +1
4740 IF (TB = 3 AND I = PHG) OR (TB = 2 AND I =PHG) THEN 4790
4750 IF TB = 3 THEN 4780
4760 IF TB = 2 THEN 4770 ELSE 4850
4770 IF V = WDW THEN 4790 ELSE CP = CP +L(L,I):CP1=CP1+L2(L,I):GOTO 4880
4780 IF V= WDM THEN 4790 ELSE CP = CP + L(L,I) :CP1 =CP1+L2(L,I):GOTO 4880
4790  CP = CP + L(L,I) :L1(L,C1) = CP :CP1=CP1+L2(L,I):L5(L,C1)=CP1
4800 IF CP > MC THEN H1 = H1 + 1 :OC = OC +CP :GOTO 4830
4810 IF CP < NC THEN H = H + 1 :UC = UC + CP :GOTO 4830
4820 H3 = H3+ 1 :CN = CN + CP
4830 C1=C1+1:  CP = 0 :CP1=0 :V=0
4840 GOTO 4880
4850 IF L(L,I) > MC THEN H1 = H1 + 1 :OC = OC +L(L,I) :GOTO 4880
4860 IF L(L,I) < NC THEN H = H + 1 :UC = UC + L(L,I)  :GOTO 4880
4870 H3 = H3 + 1 :CN = CN + L(L,I)
4880  NEXT I
4890 U1(L,1) = OC :U1(L,3) = UC:U1(L,2) = H1:U1(L,4) = H :U1(L,5)=CN:U1(L,6)=H3
4900 NEXT L
4910 REM *** ORDERS COST ***
4920 ORC = 0
4930 FOR I = 1 TO NT
4940 IF CN%= 1 THEN CO = D(I,2)-D(I,4):GOTO 4950 ELSE 4960
4950 IF CO < 0 THEN ORC = ORC + INT((-CO*D(I,5)*D(I,7)*100))/100 ELSE ORC = ORC
+ INT((CO*D(I,6)*D(I,7)*100))/100 :GOTO 4970
4960 IF CN% = 2 THEN CO = D(I,2)-D(I,4) :IF CO < 0 THEN ORC = ORC +(-INT((CO*D(I
,5)*D(I,7))*100)/100 )
4970 NEXT I
4980 RETURN
4990 REM *** ORDER SPLITTING ***
5000 REM
5010 FLAG = 1:GOSUB 630
5020 PRINT TAB(20);"ENTER ORDER TYPE ( 1- RELEASED  2-PLANNED) ";:INPUT OT
5030 IF OT <> 1 AND OT<> 2 THEN 5050 ELSE 5060
5040 IF OT = 1 THEN V3$="RELEASED" ELSE V3$ ="PLANNED"
5050 PRINT:PRINT TAB(15); "ENTER 1 OR 2 ":GOTO 5020
5060 PRINT TAB(20);"ENTER ORDER NO.                                    ";:INPUT N1
5070 IF N1 < 0  THEN 5060
5080 IF OT = 1 THEN FG$=A$  ELSE  FG$ =A1$
5090 OPEN "I",1,FG$
5100 OPEN "O",3,"FG$.TMP"
5110 INPUT #1,NW
5120 WRITE #3,NW
5130 Q =0:Z=0 :ZZ=0
5140 Q= Q+1
5150 IF Q > NW THEN 5220
5160       INPUT #1,N,PT,OQ,DD,SD,C1,C2
5170      IF N = N1 THEN 5510
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5180      WRITE #3,N,PT,OQ,DD,SD,C1,C2
5190 IF Z = 0 THEN 5210
5200 IF Z = 2 AND ZZ =1  THEN 5210 ELSE 5750
5210 GOTO 5140
5220  CLOSE 1,3
5230 IF FLAG = 1 THEN GOSUB 630 :PRINT TAB(20);"ORDER NO.";N1;" IS NOT IN ";V3$;
" ORDERS FILE PLEASE CHECK THE ORDER NO. ":GOSUB 640
5240 GOSUB 4500
5250 KILL FG$ :NAME "FG$.TMP" AS FG$
5260 IF Z = 0 THEN RETURN ELSE 5280
5270 V3$ ="PLANNED"
5280 GOSUB 630:PRINT TAB(20);"WOULD LIKE TO SAVE THE MODIFIED ";V3$;:PRINT TAB(2
0);"ORDERS FILE ON DIFFERENT FILE (Y/N)      ";:INPUT Y$
5290 IF Y$ ="Y" OR Y$="y" OR Y$="N" OR Y$="n" THEN 5300 ELSE 5280
5300 IF Y$ = "Y" THEN 5310 ELSE 5350
5310 PRINT:PRINT TAB(20);"ENTER ";V3$;" ORDERS FILE NAME    ";:INPUT F1$
5320 PRINT TAB(20);"ENTER THE DISK DRIVE ( A,B,OR C )";:INPUT D$
5330 IF D$="A" OR D$ ="a" OR D$ ="B" OR D$ ="b" OR D$ ="C" OR D$ ="c" THEN 5340
ELSE 5320
5340 A$ = D$+":"+F1$ :A1$= D$+":"+F$ :FG$ = A$:GOTO 5380
5350 GOSUB 630:BEEP:PRINT TAB(20);"WORNING :MODIFIED FILE WILL REPLACE THE ORGIN
AL,";:PRINT TAB(20);"WOULD LIKE TO SAVE IT ON A DIFFERENT FILE (Y/N) ";:INPUT Y$

5360 IF Y$ ="Y" OR Y$="y" OR Y$="N" OR Y$="n" THEN 5370 ELSE 5350
5370 IF Y$ = "Y" THEN 5310 ELSE 5380
5380 OPEN "I",1,FG$
5390 OPEN "O",3,"FG$.TMP"
5400 INPUT #1,NW1
5410 NW = NW +1
5420 WRITE #3,NW
5430 WHILE  EOF (1) = 0
5440      INPUT #1,N,PT,OQ,DD,SD,C1,C2
5450      WRITE #3,N,PT,OQ,DD,SD,C1,C2
5460 WEND
5470 CLOSE 1,3
5480 KILL FG$
5490 NAME "FG$.TMP" AS FG$
5500 RETURN
5510 REM *** DISPLAY ORDER DATA ***
5520 CLS :Z = 0:ZZ=0:NY=N:FLAG=0:COLOR 7,0,0
5530 C = 20  :L = 1:COLOR 7,2,0
5540 G$=" (PARENT) "
5550 GOSUB 5610
5560 G$=" PART #1 "
5570 C=1 : L=12:COLOR 7,5,0:GOSUB 5610:IF Z = 1 THEN 5750
5580 IF Z = 2 THEN 5180
5590 C =41:L=12:COLOR 7,5,0
5600 G$=" PART # 2":GOSUB 5610:IF Z =2 THEN GOTO 5750 ELSE 5750
5610 FOR I=L TO L+9:LOCATE I,C:PRINT"                                          ":NEX
T I
5620 L = L +1
5630  'PRINT TAB(25);V$;" ORDERS FILE "
5640  'PRINT TAB(25);"-------------------- ";PRINT
5650 LOCATE L,C:PRINT G$;" ORDER NO. ";NY;" DATA"
5660 LOCATE L+1,C:PRINT "--------------------------------":PRINT
5670 LOCATE L+2,C:PRINT "1-ORDER NO.                    :";N
5680 LOCATE L+3,C:PRINT "2-PRODUCT NO.                  :";PT
5690 LOCATE L+4,C:PRINT "3-ORDER QUANTITY               :";OQ
5700 LOCATE L+5,C:PRINT "4-DELIVERY LEAD TIME           :";DD
5710 LOCATE L+6,C:PRINT "5-STARTING PERIOD              :";SD
5720 LOCATE L+7,C:PRINT "6-UNIT EARLY FINISH COST/DAY   :";C1
5730 LOCATE L+8,C:PRINT "7-UNIT DELAY COST / DAY        :";C2
5740 RETURN
5750 GOSUB 5920:GOSUB 5900
5760 COLOR 0,3,0:LOCATE 22,1:PRINT" ENTER OPTION NO. TO CHANGE ; 0 TO CONTINUE";
:INPUT CN2%
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5770 IF CN2% < 0  OR CN2% > 7 THEN 5750
5780 IF CN2% = 0 AND Z =2 THEN ZZ=1:COLOR 7,0,0:CLS:GOTO 5180
5790 IF Z  = 0 AND CN2% = 0 THEN COLOR 7,0,0:CLS:GOTO 5180
5800 IF CN2% = 0 THEN Z=2:GOTO 5560
5810 IF Z=0 THEN Z = 1
5820 COLOR 0,3,0:LOCATE 23,1:PRINT" ENTER THE NEW VALUE ";:INPUT NV
5830 IF CN2% = 1 THEN N = NV :IF Z =1 THEN GOTO 5560 ELSE 5590
5840 IF CN2% = 2 THEN PT = NV :IF Z = 1 THEN 5560 ELSE 5590
5850 IF CN2% = 3 THEN OQ = NV :IF Z =1 THEN 5560 ELSE 5590
5860 IF CN2% = 4 THEN DD = NV :IF Z =1 THEN 5560 ELSE 5590
5870 IF CN2% = 5 THEN SD = NV :IF Z =1 THEN 5560 ELSE 5590
5880 IF CN2% = 6 THEN C1 = NV :IF Z =1 THEN 5560 ELSE 5590
5890 IF CN2% = 7 THEN C2 = NV :IF Z =1 THEN 5560 ELSE 5590
5900 LOCATE 22,1:COLOR 0,3,0:FOR I =1 TO 79 :PRINT " ";:NEXT I
5910 LOCATE 23,1:COLOR 0,3,0:FOR I =1 TO 79 :PRINT " ";:NEXT I :RETURN
5920 IF Z=1 OR Z = 0 THEN LOCATE L,1:COLOR 16,5,0:PRINT "PART #1 ";:COLOR 7,5,0:
PRINT" OF ORDER NO.";NY;" DATA "
5930 IF Z=2 THEN LOCATE L,41:COLOR 16,5,0:PRINT "PART #2 ";:COLOR 7,5,0:PRINT" O
F ORDER NO.";NY;" DATA "
5940 RETURN
5950 LOCATE L,35:COLOR 7,5,0:PRINT "        " :RETURN
5960 REM *** ERROR MASEGES ***
5970 REM
5980 IF ERR = 53 THEN BEEP:GOSUB 640:PRINT TAB(20);"FILE NOT FOUND; PLEASE CHECK
 THE FILE NAME":GOSUB 630:RESUME 600
5990 IF ERR = 70 THEN BEEP:GOSUB 640:PRINT TAB(20);"DISK  WRITE PROTECTED;PLEASE
 REMOVE IT":GOSUB 630:RESUME 600
6000 IF ERR = 61 THEN BEEP:GOSUB 630:PRINT TAB(20);"DISK  FULL ":GOSUB 640:RESUM
E 600
6010 IF ERR = 27 THEN BEEP:GOSUB 640:PRINT TAB(20);"OUT OF PAPER":GOSUB 640:RESU
ME 600
6020 IF ERR = 55 THEN BEEP:GOSUB 630:PRINT TAB(20);"FILE ALREADY EXISTS;PLEASE C
HOOSE ANOTHER NAME":GOSUB 640:RESUME 600
6030 BEEP:ON ERROR GOTO 0
6040 REM *** ZEROING ACCOM. ***
6050       Z = DD+CD+1 : T = 0 :Y1 = 0
6060    FOR I = NWC TO 1 STEP -1
6070       X = PS(PT,I)
6080       IF X = 0 THEN 6280
6090       GET 2,X
6100 NC = CVS(NC$) : MC = CVS(MC$): EF= CVS(EF$):UF=CVS(UF$):OCA= CVS(OC$):BC= C
VS(BC$):IC= CVS(IC$)
6110       EU = (EF/100)*(UF/100): NC = INT((EU*NC)*100)/100
6120       HW = -(NC)
6130       Y =-( OT(PT,I) * OQ)
6140       Y1 = Y1 + Y :'LPRINT Y1,X,L
6150       IF T < 0 THEN  Y = Y - T  :GOTO 6200
6160       Z = Z - 1
6170       IF Z <S  THEN RETURN ELSE 6180
6180         Y = Y - HW
6190         GOTO 6240
6200         IF Y >= 0 AND HW <= T+Y THEN  L(X,Z) = L(X,Z) + Y +T:T =Y+T-HW:
             IF L <= NW THEN L2(X,Z)=L(X,Z):GOTO 6270  ELSE 6270
6210         IF Y >= 0 THEN  L(X,Z) = L(X,Z) +HW:Y= Y+T-HW:GOTO 6260
6220         IF T <HW THEN L(X,Z) = L(X,Z) +HW:Y=Y+T-HW:T =0: GOTO 6260
6230         L(X,Z) = L(X,Z) + T :GOTO 6260
6240         IF Y >= 0 THEN  L(X,Z) = L(X,Z) + Y+HW:T =-Y :IF L <= NW THEN L2(X,Z
)= L(X,Z):GOTO 6270 ELSE 6270
6250         L(X,Z) = L(X,Z) + HW
6260       IF L <= NW THEN L2(X,Z)=L(X,Z):GOTO 6160 ELSE 6160
6270  REM PRINT PT,X,Z,L(X,Z) :GOSUB 420
6280   NEXT I
6290 REM *** PRINT THE REPORTS ***
6300 GOSUB 630
6310 PRINT TAB(20); "REPORTS OPTIONS :" :PRINT
6320 PRINT TAB(25);"1- PRINT WORK-CENTERS LOAD PROFILE"
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6330 PRINT TAB(25);"2- PRINT RELEASED ORDERS STATUS"
6340 PRINT TAB(25);"3- PRINT PLANNED OREDRS STATUS"
6350 PRINT TAB(25);"4- PRINT LOADING POLICY PREFORMANCE "
6360 PRINT TAB(25);"5- PRINT ALL REPORTS"
6370 PRINT TAB(25);"6- EXIT "
6380 PRINT:PRINT TAB(20);"ENTER CHOICE NO.";:INPUT CN2%
6390 IF CN2% < 1 OR CN1% > 6 THEN 6400 ELSE 6410
6400 PRINT:PRINT "CHOICE NO. MUST BE EITHER 1,2,3,4,5 OR 6":GOTO 6380
6410 IF CN2% = 7 THEN RETURN
6420 ON CN2% GOSUB 6440,6870,6870,7130,7530
6430 GOTO 6300
6440 REM *** DISPLAYING RESULT ***
6450 REM
6460 GOSUB 7580:GOSUB 7630
6470 LPRINT
6480 FOR L = 1 TO NWC
6490  OC = 0 :UC = 0 :H = 0 : H1 = 0:C1 = 1
6500 GET 2,L
6510 NC = CVS(NC$) : MC = CVS(MC$): EF= CVS(EF$):UF=CVS(UF$):OCA= CVS(OC$):BC= C
VS(BC$):IC= CVS(IC$):K = CD
6520       EU = (EF/100)*(UF/100)
6530 IF TB = 2 THEN NC = INT(((NC *WDW)*EU)*100)/100 :MC = INT(((MC *WDW)*EU)*10
0)/100
6540 IF TB = 3 THEN NC = INT(((NC *WDM)*EU)*100)/100 :MC = INT(((MC *WDM)*EU)*10
0)/100
6550 IF TB = 1 THEN NC = INT(((NC )*EU)*100)/100 :MC = INT(((MC )*EU)*100)/100
6560 'IF FLAG = -9 THEN 3070
6570 IF CN% =2 THEN LPRINT TAB(30);"LOADING POLICY   :BACKWARD":GOTO 6590 ELSE 6
580
6580     LPRINT TAB(30);"LOADING POLICY   :FORWARD "
6590    LPRINT TAB(30);"-----------------"
6600 LPRINT TAB(25);"WORK-CENTER NAME : ";WCN$
6610 LPRINT TAB(25);"--------------------":LPRINT
6620 LPRINT "NORMAL CAPACITY (PER ";V$") = "; NC ;TAB(40);"MAXIMUM CAPACITY (PER
 "V$;") = ";MC
6630 LPRINT "EFFECIENCY FACTOR           = "; EF;"%" ;TAB(40);"UTILIZATION FACTO
R          = ";UF;"%"
6640 LPRINT "OVER-MAX COST/HR.= ";OCA;TAB(27);"BTWN MAX & NOR. COST/HR.=";BC;TAB
(59);"IDLE COST /HR. =";IC
6650 FOR I =1 TO 79 :LPRINT "-";:NEXT I :LPRINT
6660  LPRINT V$;TAB(10);"REQUIRED";TAB(25);"LOAD";TAB(32);"% UTILIZED"; TAB(45);
"O";TAB(47);"= OVER LOADED"; TAB(63);"U"; TAB(65);"= UNDER LOADED"
6670  LPRINT " NO.";TAB(10);"CAPACITY";TAB(24);"STATUS"; TAB(45);"N";TAB(47);"=
NORMAL LOAD"
6680 FOR I =1 TO 80 :LPRINT "-";:NEXT I
6690 C =0
6700 IF TB <> 1 THEN PH = PH1 :K=1 ELSE K = CD
6710   FOR I = K TO PH
6720 IF TB = 1 THEN 6780
6730 LPRINT;TAB(3);I;TAB(10);CINT(L1(L,I));:IF L1(L,I) > MC THEN LPRINT TAB(25);
"O";:GOTO 6760
6740 IF L1(L,I) < NC THEN LPRINT TAB(25);"U";:GOTO 6760
6750  LPRINT TAB(25);"N";
6760 U = CINT((L1(L,I) / (NC ))*100)
6770 GOTO 6820
6780 LPRINT;TAB(3);I;TAB(10);CINT(L(L,I));:IF L(L,I) > MC THEN LPRINT TAB(25);"O
";:GOTO 6810
6790 IF L(L,I) < NC THEN LPRINT TAB(25);"U"; :GOTO 6810
6800  LPRINT TAB(25);"N";
6810 U = CINT((L(L,I) / (NC ))*100)
6820 LPRINT TAB(35);U
6830  NEXT I
6840 LPRINT :LPRINT
6850 NEXT L
6860 RETURN
6870 REM *** ORDER STATUS REPORT ***
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6880 REM
6890 GOSUB 7580:GOSUB 7630
6900 IF CN2%= 2 THEN V1$="RELEASED" ELSE V1$= "PLANNED"
6910 IF CN2%= 2 THEN K=1 :NT = NW  ELSE K = NW +1 :NT = NT1
6920 C = 0
6930      LPRINT
6940 IF CN% =2 THEN LPRINT TAB(30);"LOADING POLICY   :BACKWARD":GOTO 6960 ELSE 6
950
6950      LPRINT TAB(30);"LOADING POLICY   :FORWARD "
6960     LPRINT TAB(30);"-----------------":LPRINT
6970      LPRINT TAB(30);V1$;" ORDERS STATUS REPORT"
6980      LPRINT TAB(30);"----------------------------" :LPRINT
6990 LPRINT TAB(8);:FOR L = 1 TO 70:LPRINT"-";:NEXT L :LPRINT
7000      LPRINT TAB(10);"ORDER";TAB(17);"DUE ";TAB(24);"STARTING";
7010     IF CN% = 1 THEN LPRINT;TAB(35);"EARLIEST";TAB(45);"EARLIEST";TAB(55);"SL
ACK";TAB(65);"DELAY/EARLY" ELSE LPRINT TAB(35);"LATEST";TAB(45);"LATEST";TAB(55)
;"SLACK"; TAB(65);"(DELAY/EARLY) "
7020      LPRINT TAB(10);"  NO.";TAB(17);"DATE";TAB(24);"DATE";TAB(35);" START  "
;TAB(45);"FINISH";TAB(55);"# DAYS";TAB(69);"COST"
7030 LPRINT TAB(8);:FOR L = 1 TO 70:LPRINT"-";:NEXT L :LPRINT
7040 FOR I = K TO NT
7050     LPRINT TAB(10);D(I,1);TAB(17);D(I,2);TAB(25);D(I,3);
7060 IF D(I,4) = -1 THEN LPRINT TAB(45);"EBH";TAB(55);"*";TAB(69);"*":GOTO 16760

7070     IF CN%=1 THEN LPRINT TAB(35);D(I,3);TAB(45);D(I,4);TAB(55);D(I,2)-D(I,4)
; ELSE IF D(I,4)>D(I,2) THEN LPRINT TAB(35);D(I,3);TAB(45);D(I,4); TAB(55);D(I,2
)-D(I,4); ELSE LPRINT TAB(35);D(I,4);TAB(45);D(I,2);TAB(55);D(I,4)-D(I,3);
7080 IF CN%= 1 THEN CO = D(I,2)-D(I,4):GOTO 7090 ELSE 7100
7090 IF CO < 0 THEN LPRINT TAB(69);INT((-CO*D(I,5)*D(I,7)*100))/100 ELSE LPRINT
TAB(69);INT((CO*D(I,6)*D(I,7)*100))/100 :GOTO 7110
7100 IF CN% = 2 THEN CO = D(I,2)-D(I,4) :IF CO < 0 THEN CO1=-INT((CO*D(I,5)*D(I,
7))*100)/100 :LPRINT TAB(69);CO1 ELSE LPRINT TAB(70);0
7110 NEXT I
7120  RETURN
7130 REM *** POLICY  STAT. ***
7140 REM
7150 GOSUB 7580:GOSUB 7630
7160 C = 0 :UT1=0:DD1=0:OV1=0:AC1=0:GOC=0:IC2=0:BC2=0:OCA2=0:Y=.001
7170 IF TB <> 1 THEN PH = PH1
7180      LPRINT
7190 IF CN% =2 THEN  LPRINT TAB(30);"LOADING POLICY :BACKWARD ":GOTO 7210 ELSE 7
200
7200       LPRINT TAB(30);"LOADING POLICY :FORWARD "
7210      LPRINT TAB(30);"-------------------" :LPRINT
7220 FOR L = 1 TO 78:LPRINT"-";:NEXT L :LPRINT
7230   '  PRINT TAB(1);"WORK-CENTER";TAB(20);"# OF ";V$;TAB(35);" AVERAGE";TAB(50
);"# OF ";V$;;TAB(65);"AVERAGE"
7240  LPRINT "WORK-CENTER";TAB(16);"AVG. LOAD";TAB(25);"  %     ";TAB(34);"  %  "
;TAB(43);"OPERATIONAL COST "
7250     PRINT "     NAME    ";TAB(17);"/";V$;TAB(26);"IDLE";TAB(32);"OVER-MAX";TAB
(42);"IDLE";TAB(49);"OVER-MAX";TAB(59)"BTWN. MAX&NOR";TAB(74);"TOTAL"
7260 FOR L = 1 TO 78:LPRINT"-";:NEXT L :LPRINT
7270 FOR I = 1 TO NWC
7280 GET 2,I
7290 NC = CVS(NC$) : MC = CVS(MC$): EF= CVS(EF$):UF=CVS(UF$):OCA= CVS(OC$):BC= C
VS(BC$):IC= CVS(IC$)
7300       EU = (EF/100)*(UF/100)
7310  NC = INT(((NC )*EU)*100)/100 :MC = INT(((MC )*EU)*100)/100
7320 TC = U1(I,1)+U1(I,3)+U1(I,5)
7330 TCN = NC * PH3
7340 ID = TCN - U1(I,3)
7350 UT= CINT((TC/TCN)*100): DD=CINT((ID/TCN)*100):OV=CINT((U1(I,1)/TCN)*100):AC
=CINT((TC/PH))
7360   ' PRINT TAB(1);WCN$; TAB(22);U1(I,2);
7370 IC1= CINT(IC*ID):BC1=CINT(BC*U1(I,5)):OCA1=CINT(OCA*U1(I,1))
7380 TOC = IC1+BC1+OCA1 :GOC =GOC+ TOC
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7390   LPRINT WCN$; TAB(17);AC ;TAB(26);DD;TAB(32);OV;TAB(42);IC1;TAB(49);OCA1;T
AB(64);BC1;TAB(74);TOC
7400  'IF U1(I,2) > 0 THEN PRINT TAB(38);INT((U1(I,1)/U1(I,2))*100)/100; ELSE PR
INT TAB(38);0;
7410 '  PRINT TAB(50);U1(I,4);:IF U1(I,4) > 0 THEN PRINT TAB(67);INT((U1(I,3)/U1
(I,4))*100)/100 ELSE PRINT TAB(67); 0
7420 UT1 =UT1 +UT :DD1 = DD1 +DD:OV1=OV1+OV:AC1=AC1+AC:IC2=IC2+IC1:BC2=BC2+BC1:O
CA2=OCA2+OCA1
7430 NEXT I
7440 FOR L = 1 TO 78:LPRINT"-";:NEXT L :LPRINT
7450 B = I -1
7460 LPRINT "OVERALL AVERAGE ";TAB(17);INT((AC/B));TAB(26);INT((DD1/B));TAB(32);
INT((OV1/B));TAB(42);INT((IC2/B));TAB(49);INT((OCA2/B));TAB(64);INT((BC2/B));TAB
(74);INT((GOC/B))
7470 FOR L = 1 TO 78:LPRINT"=";:NEXT L :LPRINT
7480 LPRINT"TOTAL OPERATIONAL  COST";TAB(70);GOC
7490 LPRINT"TOTAL DELAY/EARLY DELIVERY COST";TAB(70);ORC
7500 FOR L = 1 TO 78:LPRINT"=";:NEXT L :LPRINT
7510 LPRINT"LOADING POLICY GRAND TOTAL COST";TAB(70);ORC+GOC
7520 RETURN
7530 REM *** PRINTING ALL REPORS ***
7540 GOSUB 7580:GOSUB 7630
7550 REM
7560 GOSUB 6470:GOSUB 6900:GOSUB 7160
7570 RETURN
7580 GOSUB 630:BEEP:PRINT TAB(35);:COLOR 16,7,0
7590 PRINT "    PLEASE CHECK     " :COLOR 7,0,0
7600 PRINT TAB(35);:COLOR 0,7,0
7610 PRINT TAB(35);" IF PRINTER IS READY "
7620 COLOR 7,0,0 :GOSUB 640 :RETURN
7630 GOSUB 630:PRINT TAB(35);:COLOR 0,7,0
7640 PRINT "                 " :COLOR 7,0,0
7650 PRINT TAB(35);:COLOR 16,7,0
7660 PRINT "   PRINTING   " :COLOR 7,0,0
7670 PRINT TAB(35);:COLOR 0,7,0
7680 PRINT "                 " :COLOR 7,0,0
7690 RETURN
```

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